

THURSDAY, JANUARY 22, 1891.

## NATURE OF KOCH'S REMEDY.

SINCE Koch announced at the meeting of the International Medical Congress in Berlin, more than five months ago, that he had discovered a remedy for tuberculosis, a lively curiosity has been felt as to the nature of this remedy. This curiosity has now been gratified, and on another page we reproduce the paper in which Koch has explained both the nature of the remedy and the experiments which led him to employ it.

The remedy is a glycerine extract of pure cultivations of tubercle bacilli. It does not appear from Koch's paper what the media were in which the tubercle bacilli were cultivated, and this is a matter of some importance, because it is quite possible that bacilli cultivated in gelatine, in meat broth free from albumen, and in albuminous solutions may yield different products. Thus, Hoffa extracted ptomaines from cultivations of anthrax bacillus grown upon meat, but did not obtain them from the same bacillus when grown upon broth; and Brunton and Macfadyen have found that bacteria appear to have the power of adapting themselves to the soil upon which they grow, by forming such unorganized ferments or enzymes as will decompose it and render it soluble so as to be suitable for their nutrition. Thus certain bacilli when grown upon a starchy soil form an enzyme which will convert the starch into sugar, while the same bacilli grown upon albuminous soil form an enzyme which converts the albumen into peptone.

The quantity of active material produced by the tubercle bacilli is, according to Koch, very small, and he estimates the amount of it in the glycerine extract he employs at fractions of 1 per cent. In its nature it appears to be allied to enzymes and peptones, for, while closely related to albuminous bodies, it does not belong to the group of so-called tox-albumens. Like unorganized ferments or enzymes, and like peptones, it is precipitated by alcohol, but it differs from the former and resembles the latter in its power of rapid diffusion. In addition to this soluble substance, the tubercle bacilli seem to produce another body which adheres closely to them, is not readily removed by solvents, and tends to produce local suppuration when injected under the skin of an animal, while the soluble material which forms the active part of the curative lymph has no such action. Koch has already shown that the tubercle bacillus, unlike the anthrax bacillus, is of a very slow growth, so that when cultivated on a glass covered with coagulated serum ten days elapse from the time of inoculating the slide before the growth of the bacillus becomes at all abundant. A similar condition occurs when the bacillus is inoculated subcutaneously in a healthy guinea-pig. After inoculation the wound generally closes up, and appears to heal entirely within a day or two. In ten to fourteen days afterwards, when the tubercle bacillus has begun to grow, a hard nodule appears, which soon opens and an ulcer forms, lasting until the death of the animal. At the same time as the ulceration begins, the lymphatic glands swell up, the animal becomes emaciated, and death occurs from the lungs and other organs being invaded by the bacilli.

which are carried to them by the blood from the point of inoculation. When a similar injection is made in an animal which has been already rendered tuberculous by previous inoculation, instead of no local symptoms appearing at the point of inoculation for ten days, as in the healthy animal, the place where the needle has been introduced appears on the first or second day hard and dark, and this condition spreads a short distance around. The dark colour indicates that the cells of the tissue round the spot of inoculation have become dead, and they are thrown off, leaving an ulcer which heals quickly and completely, and does not infect the neighbouring glands. Koch's further experiments showed that the local ulceration produced in the way just described was not due to living tubercle bacilli, for a similar result was obtained when they had been killed by boiling or by the action of disinfectants. It was therefore clear that the effect was produced by chemical substances, either entering into the composition of the bacilli, or closely associated with them. When pure cultivations of dead bacilli were diluted in water, they produced nothing more than local suppuration in healthy guinea-pigs; but in guinea-pigs already rendered tubercular by previous inoculation a very small quantity was sufficient to produce death, while a still smaller quantity, too small to kill the animal, was sufficient to produce widespread necrosis round the point of inoculation. When still further diluted, the injection of the fluid, so deadly in large doses, becomes salutary; the animals improve in condition, local ulceration diminishes and finally heals up, the swollen glands become smaller, the disease is arrested, and, if not too far gone, the animal recovers. The objection to using diluted cultures of dead tubercle bacilli is that the bodies of the bacilli are not readily absorbed, and give rise to suppuration. The glycerine extract, on the contrary, gives rise to no suppuration, and produces all the general conditions just described as occurring after the injection of the dead bacilli. In Koch's first paper (*vide* NATURE, November 20, 1890, p. 68), he was careful to point out that his remedy would not be of universal application, and said:—"I would earnestly warn people against conventional and indiscriminating application of the remedy in all cases of tuberculosis." He insisted on the fact that his remedy did not kill the tubercle bacillus, but only the tissues in which it was present, and pointed out that in cases where the necrosed tissue could not be removed his remedy was not likely to be of use. But Koch's warnings have been to some extent neglected, and his remedy has been used in unsuitable cases, with the result, as might have been expected, that harm, and in some cases death, has been produced. For example, it has been used in tubercular disease of the membranes of the brain, with the worst possible results.

The remarks of Prof. Virchow, summarized in NATURE of January 15, are probably only the beginning of a flood of unfavourable criticism which will be made upon Koch's remedy during the next few months. During the last month or two unwarranted expectations have been entertained by very many regarding the curative powers of Koch's lymph, and when these hopes are dashed they are likely to be succeeded by equally unwarranted abuse of the remedy.

As we pointed out in our issue of November 20, 1890,

although analogy pointed to cultivations of the tubercle bacillus as being likely to prove preventive or curative in tuberculosis, and although Koch's present paper shows that they are what he has actually employed, still a consideration of the nature of phthisis would lead one to doubt whether these were actually the best adapted for the purpose of curing consumption, and whether we might not yet find cultivations of other disease germs more likely to cure this disease than cultivations of the tubercle bacillus itself. Most of the results which have hitherto been obtained confirm those put forward by Koch in his original paper, and they also show very clearly indeed the necessity for the closest attention to the caution in the use of the remedy which he earnestly enjoined. As a means of diagnosing phthisis in its earliest stages, Koch's lymph is certain to prove a most valuable if not an absolutely infallible means of diagnosis, and will thus ensure proper care in those cases where at present the slightness of the symptoms leads to doubt on the part of the physician, and sometimes to indiscretion on that of the patient. In such cases, as well as in lupus, it is likely to prove a potent curative agent, and to fulfil to a great extent the hopes expressed by Koch himself in the careful and moderate manner which is characteristic of the man. As its failure to effect everything that the public expected becomes generally known, we may expect to hear it even more abused than it has been praised; but it will nevertheless remain a great addition to our power of recognizing and treating consumption, as well as an earnest of yet better things to come.

#### INDIAN BIRDS.

*The Fauna of British India, including Ceylon and Burma.* Published under the authority of the Secretary of State for India in Council. Edited by W. T. Blanford. "Birds," Vol. II. By Eugene W. Oates. 8vo, pp. i.-x., 1-407. (London: Taylor and Francis, 1890.)

MR. OATES has, for the present, finished his work on Indian Birds, with the present instalment. It is satisfactory to learn, on the one hand, that the Indian Government so highly appreciate his administrative abilities in Burma, that they could not grant him the extra furlough necessary to complete his scientific work, and he was thus forced to terminate his duties in England, to return to his post in the Public Works Department at Tounghoo. It may be India's gain thus to sever him from the work which he so dearly loved and which he has executed with such conspicuous ability, but it will prove a loss to science, and it will be very hard to find anyone capable of continuing the description of the Birds of India in the same complete way that Mr. Oates has done. As the work has been done almost entirely in the writer's private room at the Natural History Museum, he is able to speak with some authority on the subject, and he wishes thus publicly to acknowledge the earnestness with which Mr. Oates wrote his book, the consideration which he showed for the officers of the Zoological Department, and the care which he took of the specimens, numbering many thousands, which passed through his

hands. Curators of Museums will understand what we mean, for there is no part of their duty more irksome than the constant vigilance which is required to supervise the treatment of specimens by students, who seem to be often animated with the sole idea that when they have seen a specimen for their own purposes, it matters little whether the future investigator finds it with its head or wings off, or not. We only wish that every student of birds were endued with the reverent love for a well-prepared specimen which animates Mr. Oates and a few other naturalists we could mention. This by the way.

With the first portion of the second volume of the "Birds," Mr. Oates completes his account of the Passeres or Perching Birds of the British Asian Empire. Following out his ideas of classification, he first describes the Flycatchers and Thrushes, and follows them with the Dippers and Accentors. Then come the Weaver Birds and Finches, Swallows, Wagtails, Larks, ending with the Sun-birds, Flower-peckers, and, of course, finally with the Ant-thrushes or Pittidæ. No one will find fault with the position of the latter; but we greatly question the natural sequence of the other families. No one can doubt that Mr. Oates, in his classification of the Passeres, the most difficult of all ornithological problems, has advanced our knowledge of the characters of differentiation, but we must demur to some of his conclusions. However, here is a genuine piece of work, with chapter and verse for every one of the author's opinions, and we will therefore append a succinct account of the new facts brought forward by the author, and give a practical aspect to the present review.

#### Fam. MUSCICAPIDÆ.

*Muscicapa parva* is a *Siphia*. Oates, *t.c.*, p. 9. [This is an innovation, to be accepted with caution, for it introduces *Siphia*, hitherto an Indian genus, into the Palearctic Region.]

*Muscicapa albicilla* is a *Siphia*. Oates, *t.c.*, p. 10. [This follows as a matter of course, as the species is the Eastern representative of *M. parva*.]

*Muscicapa hyperythra* is a *Siphia*. Oates, *t.c.*, p. 10. [[So Cabanis was right, according to Mr. Oates, in describing this bird as a *Siphia*.]

*Cyornis* should be separated from *Siphia*, and not united to it, as has been done by Sharpe, as there is blue in the plumage. *Ergo*, *Muscitrea cyanea* is a *Cyornis*. Oates, *t.c.*, p. 13. [This is an aggregation of species, which we do not think will be ratified.]

*Poliomyias hodgsoni* (Verr.) apud Sharpe, is a *Cyornis*. Oates, *t.c.*, p. 14.

*Muscicapula hyperythra* (Blyth) apud Sharpe, is a *Cyornis*. Oates, *t.c.*, p. 15.

*Digena leucomelanura* (Hodgs.) apud Sharpe, is a *Cyornis*. Oates, *t.c.*, p. 16.

*Muscicapula superciliaris* (Jerd.) apud Sharpe, is a *Cyornis*. Oates, *t.c.*, p. 17.

*M. melanoleuca*, Blyth (*M. maculata*, Tickell, apud Sharpe) is a *Cyornis*. Oates, *t.c.*, p. 18.

*M. astigma* (Hodgs.) and *M. sapphira* (Tick.) apud Sharpe, belong to *Cyornis*. Oates, *t.c.*, pp. 19, 20.

*Niltava oatesi* (Salvad.), is a *Cyornis*. Oates, *t.c.*, p. 21.

*Siphia pallidipes* (Jerd.) and *S. unicolor* (Blyth) apud Sharpe, belong to *Cyornis*. Oates, *t.c.*, pp. 22, 23.

*Muscitrea grisola* (Blyth) is a Flycatcher, not a Shrike. Oates, *t.c.*, p. 31.

*Cyornis poliogenys*, Brooks, and *C. olivacea*, Hume, belong to the genus *Anthipes*. Oates, *t.c.*, pp. 33, 34.

*Alseonax mandellii* (Hume) = *A. multui*, Layard. Oates, *t.c.*, p. 36.

*Terpsiphone nicobarica*, sp.n. Oates, *t.c.*, p. 45.

*Hypothymis tytlerti*, from the Andamans, distinct from *H. azurea*. Oates, *t.c.*, p. 50.

Family TURDIDÆ.

*Pratincola robusta*, Tristram, said to be from Bangalore, is a Madagascar bird. Oates, *t.c.*, p. 58.

*Saxicola barnesi*, sp.n., from Afghanistan. Oates, *t.c.*, p. 75.

*Cochia* is allied to *Geocichla*. Oates, *t.c.*, p. 158.

Family MOTACILLIDÆ.

*Anthus cockburniæ*, sp.n., from the Nilghiris. (*A. sordidus*, Sharpe (nec Rüpp.). Oates, *t.c.*, p. 305.

Family NECTARINIIDÆ.

*Ethopyga anderssoni*, sp.n., from Upper Burma. Oates, *t.c.*, p. 349.

*Chalcophaps* is not a Sun-bird, but is allied to *Zosterops*. Oates, *t.c.*, p. 373.

Family DIEËIDÆ.

*Acomorhynchus*, gen. n. Type *A. vincens* (Scl.). Oates, *t.c.*, p. 382.

Besides these new features in Mr. Oates's book, there are many valuable criticisms on less important matters. One further point should be mentioned, as it was missed by ourselves in the British Museum "Catalogue," and Mr. Oates has unfortunately followed our lead. *Erythrospiza* of Bonaparte is quoted as published in 1831, but we quote from a letter of Count Salvadori: "You will find it in the 'Osservazioni el Regno animale del Barone Cuvier' (p. 80), and it is equivalent to *Carpodacus* of Kaup. So the genus *Bucanetes* must be used."

In a comprehensive work like this one of Mr. Oates, it is unlikely that all his conclusions, many of them novel and unexpected, will commend themselves at once to ornithologists. Our own opinion is that he has gone a little too far in promoting his theory of the value of the style of plumage in the young birds; but no one will deny that, for conciseness and painstaking labour, Mr. Oates's volumes are a model of what an advanced "hand-book" should be, and he has set such a high standard of work, that Mr. Blanford, who announces his intention of completing the ornithological portion of the "Fauna," will find it no easy task to follow in Mr. Oates's footsteps. As the latter gentleman is prevented by his superior official duties from continuing his work, it is at least fortunate that such a conscientious naturalist as Mr. Blanford has undertaken the task of completing the work which Mr. Oates has so well begun. We may add that the woodcuts by Mr. Peter Smit are as good as those which he drew for the first volumes of the "Birds," and are excellent in every way.

R. BOWDLER SHARPE.

A MANUAL OF PUBLIC HEALTH.

*A Manual of Public Health.* By A. Wynter Blyth, M.R.C.S., L.S.A. (London: Macmillan and Co., 1890.)

EARNEST efforts are being made to insist that candidates for the appointment of a medical officer of health shall have an adequate knowledge of sanitary science. The issue of this volume is therefore opportune. All the subjects of which a knowledge is required in

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examinations in hygiene and sanitary science are dealt with. Necessarily the ground travelled over is extensive, and some of the sections have not received that comprehensive treatment which they appear to us to need.

The matter is discussed under twelve heads. The first section is occupied with a brief account of vital statistics, but only in so far as they affect the duties of a health officer. As far as the subject is taken up it is clearly and lucidly treated, the description of the construction of life tables being particularly good. The section on air, ventilation, and warming is written in a thoroughly practical manner, but in describing the mechanical appliances for ventilation the author gives no illustrations, nor does he touch upon the ventilation of ships. The chapter concludes with an elaborate account of the methods of calculating cubic space, which, although useful for reference, is probably seldom required by the medical officer of health in his daily duties. In the description of hygrometers Daniels's does not find a place.

The first part of section iv., dealing with the sources of water-supply, is disappointing, for the subject has not received the share of attention which it decidedly merits. Cisterns obtain mention only as a necessary evil in an intermittent system of water-supply, there being no description of their varieties, and the dangers associated with the use of objectionable kinds. The water-supply of the metropolis is minutely detailed, full particulars being given of the exact area and districts supplied by the companies, the amount of water daily drawn from the Thames, the filtering appliances, and the average composition of the water distributed. The analysis of water is exhaustively discussed, and amongst the apparatus employed is a description of the useful pipette invented by the author. In section v., treating of drains, the varieties of drain-traps might perhaps have been more fully discussed, and the man-hole or disconnecting chamber dwelt on at greater length.

Like the water-supply, the sewage of the metropolis receives the most careful consideration, and the chapter on it contains an excellent explanation of the plan of the London drainage, together with a map of the same. In the treatment of sewage, precipitation processes receive a very brief notice. The subject of nuisances, so important for medical officers of health, is very fully entered into, the chapter embodying all the researches of Dr. Ballard on effluvium nuisances, and his recommendations for their removal.

Section vii., on disinfection, leaves nothing to be desired. Microparasitic diseases receive a greater share of attention than any other subject in the book, the bacteriology of each of the zymotic diseases being comprehensively treated. We do not of course underrate the value of such knowledge, but it appears to us that much of the detail which has been introduced would have been more suitable to a text-book on pathology than to one on public health. The remaining sections of the volume are devoted to isolation, hospitals, food, and the duties of sanitary officers.

On the whole, Mr. Wynter Blyth may be congratulated on the excellent text-book he has produced, based as it is upon the practical experience of many years of sanitary work, obtained in one of the largest metropolitan districts. If we have pointed out a few shortcomings, they have

been those of omission, and common to most authors. Of the high value of the work as a text-book of public health there can be no question; and we hope that Mr. Blyth's manual will be in the hands, not only of students, but of all those whose calling is sanitary science.

J. H. E. BROCK.

#### OUR BOOK SHELF.

*Lehrbuch der Zoologie für Studierende und Lehrer.* Von Dr. J. E. V. Boas. Mit 378 Abbildungen. (Jena: Gustav Fischer, 1890.)

THIS newly published manual of zoology is a translation of the author's work, which was published in Danish in 1888. It is written from the modern standpoint, dwelling rather on the embryological and structural details of the forms of animal life, and using the scheme of classification as a subject of secondary importance. While the present volume is based on the author's previous work, it is no mere translation; not only is there a quite new chapter added under the heading of "Biology," in which the distribution of animals on land, sea, and fresh water, parasitism, non-locomotory animals, and such like subjects are briefly discussed, but changes have been made in the species of animal forms selected for illustration when those previously selected would not have been easily attainable by the German student. New figures have been introduced, and the work has generally been revised. The author warmly thanks Prof. Spengel, of Giessen, for much help rendered in the revision of the translation, German not being Dr. Boas's mother tongue. The first portion of this manual treats of the cells and tissues, the various organs or systems, development, and phylogeny, and includes the chapter above-mentioned on biology, and on the distribution of animals in space and time. The special portion treats of the classes of animals, from the Protozoa to Mammalia. Certain groups, the position of which is uncertain, are treated as "appendages" to the larger ones, such as the Sponges to the Coelenterates, the Tunicates to the Vertebrates, &c. Possibly, from the student point of view, this is going too far afield. Another point that struck us in a perusal of this volume was the absence of all references to the work of others in this field of zoology. We are very far from suggesting that it would be desirable to refer, in a necessarily compressed statement of facts, to the first discoverer of, or recorder of, the same; but there have been some epoch-making discoveries, such as have revolutionized our ideas of development, structure, and classification, and we think it a good plan to let the student know the names of the authors of these, as we fancy that, by doing so, the facts are all the more impressed upon his mind. In some few cases we would even go further, and, by telling the student where to look for further details, try and interest him in bibliography. It may be as well to add that in an indirect way this reference to the labours of others is, in a few instances, made in this volume, for some of the illustrations are inscribed as "after Allmann, Huxley, Weismann, Sars," &c.

The great majority of the figures are well selected, and the volume of nearly six hundred pages is published in a style worthy of the firm which introduced Balfour's "Comparative Embryology" to the German student, and that has introduced to us the works of the Hertwigs, Kölliker, Lang, Weismann, and others.

*A Pocket-book of Electrical Rules and Tables.* Seventh Edition. By John Munro, C.E., and Andrew Jamieson, M.Inst.C.E., F.R.S.E. (London: Charles Griffin and Co., 1891.)

THE rapid progress made in the application of electricity for various purposes makes it necessary for every engineer

to carry about with him some book to which he may refer. The present work has for some time been a boon to many, and its value has been increased by the improvements in the new edition. Among several additions by which the book is enriched is an article on telephony, by J. D. Miller. Not the least important item is the admirable and well-arranged index, which in a work of this kind is so essential.

#### LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

##### "Modern Views of Electricity"—Volta's so-called Contact Force.

DR. LODGE'S treatment of this subject at pp. 107-114 of his book presents at first certain difficulties. It is in the hope that he or some of his numerous readers may give a fuller explanation that I communicate them to NATURE.

We are told (p. 112) that a piece of isolated zinc has potential 1·8 volts below that of the surrounding air. This, it is said, is owing to the affinity of zinc for oxygen, and to the fact that atoms of oxygen combining with the zinc bring with them negative electricity. But (p. 110) the zinc cannot thus combine with many atoms, receiving their charges, without becoming so negatively charged as to repel oxygen atoms electrically as much as it attracts them chemically. This, indeed, may be considered as the state of equilibrium which is instantaneously attained.

In this passage Dr. Lodge does not explain how the oxygen atoms come by their negative charge. We can understand how they come to have it in electrolysis, to which we are told to compare the Volta phenomena. In case of electrolysis, oxygen atoms, seeking to combine with zinc, have first to dissolve partnership with atoms of hydrogen, and the condition of that dissolution of partnership is that oxygen goes away with a negative, and hydrogen with the corresponding positive charge. But in air atoms of oxygen exist only in combination with other like atoms, forming molecules of oxygen. And unless these molecules are negatively charged, it is difficult to see why on their dissolution the atoms combining with zinc are charged negatively.

We are told further (p. 110) that when metallic contact is made between zinc and copper, a rush occurs of positive electricity from copper to zinc, and of negative from zinc to copper, bringing both metals to a common potential 1·3 volts below the surrounding air. If that be so, the equilibrium which we said was attained in the case of the zinc is destroyed. The zinc, having by this rush been deprived of part of its negative charge, it can no longer be true that it "repels oxygen atoms electrically as much as it attracts them chemically." We should expect that a further combination of oxygen with zinc would take place, renewing the negative charge on the zinc, and causing a further rush of positive electricity from the copper. In fact, the conditions of equilibrium, when copper and zinc are in contact, seem to be unexplained.

Again, to explain the Thomson experiment with the aluminium needle (p. 111), Dr. Lodge says that the air near a couple of zinc and copper plates in contact is in a state of electrostatic strain, being at higher potential near the zinc than near the copper. But why should this be so if the two metals are at a common potential? And is it not inconsistent with the statement that the two metals are at a common potential 1·3 volts below the surrounding air? S. H. BURBURY.

WITH much pleasure do I reply to Mr. Burbury's questions concerning the Volta effect, but must refer him to my memoir on the subject, "Seat of E.M.F. in Voltaic Pile," published by Messrs. Taylor and Francis, for the complete statement and argument, of which only a brief and picturesque summary is given in "Modern Views."

(1) The difficulty which Mr. Burbury mentions concerning the electric charge of gas atoms is a very real one, but it is not a difficulty peculiar to Voltaic doctrine; and, however it is to be accounted for, the fact that gas atoms are charged seems well

established by recent researches on gaseous conveyance of electricity and vacuum-tube phenomena. This, however, is a large subject, and cannot yet be regarded as by any means satisfactorily understood; though everything points to the fact that gases transmit currents by atomic convection, *i.e.* electrolytically.

(2) When copper touches zinc, the previous state of equilibrium is disturbed, and a fresh equilibrium is set up, into which dielectric strain in the surrounding insulator enters as a prominent component. Attack of the zinc, and continuous progression of electricity, are precisely what then tend to occur, being only prevented by the insulating character of the medium. Permit it to conduct, and the whole at once becomes a Voltaic cell on closed circuit.

(3) If the potential of a metal is defined as Sir W. Thomson defines it, *viz.* as the potential energy of a unit charge in the air close to the metal, the statement quoted from p. 111 must of course be modified; but if, as I venture to hold, it is more convenient to define the potential of a metal as the potential energy of a small unit charge in or on the metal itself, the statement involves no difficulty, and is, I believe, true. An intrinsic step of potential exists between each metal and the air in contact with it, which step is constant for each metal and calculable from thermo-chemical data; if therefore by metallic contact two metals be forced to the same potential, it at once follows that a slope of potential is set up in the air from one to the other. This is the very thing observed in all static Volta experiments, and has been cursorily stated as if it were a difference of potential between the metals themselves.

I think Mr. Burbury will find this quite clear if he does me the honour to read the complete argument; but if he still perceives a difficulty, I shall be much interested in hearing from him further.

OLIVER J. LODGE.

#### Attractive Characters in Fungi.

It is to be hoped that the interesting discussion on the colours and attractive characters of fungi may induce someone, with the requisite time and patience, to undertake a study in this rich field of investigation, which has scarcely been entered. In a paper published in the *Annals of Botany* (vol. iii., No. 10, May 1889) it is shown that among the Phalloidei the coloration, odour, and contrivances for the attraction of insects for the dispersion of the spores are as remarkable as those possessed by many Phanerogams for cross-fertilization. Among 1288 species of fungi, other than Phalloids, tabulated from Bulliard's "Champignons de la France," Tulasne's "Fungi Hypogaei," and Cooke's "Agarici," the proportion of those with inconspicuous colours is about 73 per cent., while among the Phalloids the proportion is under 2 per cent.; 90 per cent. of the latter being either red or white. According to Köhler and Schubler, as quoted by Balfour, the proportion of inconspicuously coloured flowers, among 4197 species tabulated, is about 4 per cent., the proportion of red and white being slightly over 50 per cent. Seventy-six per cent. of Phalloids have functionally attractive odour, and only 9.9 per cent. of flowers; and 18.6 per cent. of these fungi have rayed or stellate forms, so common among flowers—a shape which I have shown by measurement and experiment to be that which gives the maximum conspicuousness at moderate distances (*i.e.* within the range of insects' vision) with the minimum expenditure of material. In *Coprinus*, where the spores become immersed in black and frequently very fetid fluid, some species appear to resemble certain composite flowers which are visited by large numbers of flies, and Dr. Haas has found glucose in the hymenial fluid. There are reasons to suppose that the factor developed by *Phallus* may be due to the secondary action of putrefactive bacteria.

From analogy it is probable that the colours and many of the characters in other groups are not adventitious, but have been selected to aid in the preservation of the species; *e.g.* the *Perizae* are even more brilliantly coloured than the Phalloidei, and have the hymenial surface and spores freely exposed, and many small forms (*Amanita*, *Mycena*) are beautifully coloured, and grow in places where insects abound. In other cases the colours are no doubt protective by inducing resemblance, or by conspicuousness, as in many brightly-coloured poisonous forms (procrystic and aposematic colours of Poulton). I would suggest that in some cases the glutinous character referred to by Mr. Worthington Smith and Dr. Cooke may be protective against the attacks of animals, as insects and slugs. Of hundreds of specimens of *Phallus impudicus* which I have examined, I never

found the gelatinous layer eaten through by slugs, although the spongy stem after emergence from the volva is frequently so eaten, and numbers of Agarici and other forms not so protected are attacked by insects and slugs. It is known that the mucoid secretion of slugs tends to protect them from the attacks of birds and ants, and other enemies.

T. WEMYSS FULTON.

20 Royal Crescent, Edinburgh, January 10.

#### The Morphology of the Sternum.

My friend Prof. T. J. Parker has in these pages (Dec. 11, 1890, p. 142) lately recorded the existence of a sternum in the shark *Notidanus indicus*. The anterior of the two cartilages which he figures has been already described by Haswell (Proc. Linn. Soc. N.S.W., vol. ix., part 1); and, in view of Parker's conclusions, it is interesting to note that he speaks of it (p. 23) as "temptingly like the presternal," but that "the presence of such an element in the skeleton of any group nearer than the Amphibia seems to preclude this explanation." That the Amphibian sternum is for the most part, if not wholly, a derivative of the shoulder-girdle, there can no longer be a question; and, although the researches of Goette leave us in doubt concerning the hypo (post-omo) sternum, they show that that can be no derivative of the costal apparatus. Working anatomists will realize in Parker's application of Albrecht's terminology the expression of a fundamental difference between the sternal skeleton of the Ichthyopsida and Amniota. The researches of Goette, Hoffmann, Ruge, and others, show the sternum of the higher Amniota to consist of a greater costal portion and of lesser ones, chief among the latter being the episternum or interclavicle. They suggest (especially if Hoffmann's assertion that the precoracoid or clavicular bar is, in Mammals, primarily continuous with the spine of the scapula) that the interclavicle may be, throughout, the vanishing vestige of the coracoid sternum of the Ichthyopsida. The latter would appear, therefore, to have been replaced in time by the more familiar costal sternum, derivative of the hæmal arches (ribs); and, this being so, might we not boldly, and with advantage, go a step further than Parker has done, and distinguish between a coracoid archisternum of the Ichthyopsida, and a hæmcoracoid neosternum of the Amniota? If this be conceded, the characters referred to must be incorporated in our diagnoses of the two great types named.

G. B. HOWES.

South Kensington, January 12.

#### Stereoscopic Astronomy.

THE following exquisite test of the delicacy to which astronomical photography has attained may be interesting. In Admiral Mouchez's "Photographie Astronomique" (1887)—a small book, and cheap—are eight photographs of Jupiter, by the MM. Henry, taken on April 21, 1886. Several are at intervals of only three minutes in time. What with the large red spots, the irregularities of the two belts, and white spots on the upper belt, there are quite details enough to enable the eye to perceive the solidity of the planet, in a stereoscope, if the earlier picture is submitted to the right, and the later to the left eye. Reversing the order of the pictures gives a puzzling effect, which, with a little practice, is seen to be hollowness instead of solidity. But the mind resents this true result, and so gets puzzled.

To satisfy myself that I was not, on the other hand, misled by the wish to see solid, I put the matter to the proof by asking a friend to shuffle the photographs, and submit any two to me in the stereoscope without either of us knowing which they were, or in which order they were placed. After recording my judgment, "solid" or "hollow," on each pair, the times and order of place were ascertained and recorded. I found that I was able, after twenty trials, not only to say whether two images taken three minutes apart were rightly or wrongly placed in the stereoscope, but I could guess in any case with some accuracy what the interval was before either of us knew it. This, of course, was only possible by familiarity with these particular images.

W. J. H.

Lawn-Upton, Littlemore, January 17.

#### Mock Sun.

LAST evening, about five minutes after five o'clock, I observed that a cloud in the south-west was strongly illuminated from below. As the sun had set more than half an hour, and considerably more to the south, I was surprised by the degree of

illumination. Observing more closely, I saw about 5° above the horizon, and about 12°-15° north of Hartland Point, the appearance of the sun in a fog, but only about one-third the apparent diameter when in the same place. I watched it for about five minutes, when it was gradually obscured by the rising mist.

T. MANN JONES.

Northam, Devon, January 17.

#### Our Latest Glacial Period.

I AM informed that near the Wash, and I suppose at other parts of the coast, the sea at low water is frozen into masses which with the rising tide become floes, and are urged backwards and forwards on the beach. This is, I believe, not a frequent occurrence on our shores, and it would be interesting if any observers could note whether the shingle or the stones embedded beneath the floes, when such are found, have become polished or scratched as by glacial action.

W. ATKINSON.

17 Trafalgar Square, Chelsea, S.W., January 5.

P.S.—My anticipation has proved correct as far as the small bergs in the Thames are concerned, for after a little search I have found in Chelsea Reach chalk blocks with grooves and striations that would be no discredit to a boulder clay specimen. I should be glad to hear of any similar markings on flint, chert, or other hard rocks, or even on limestone or sandstone, and also to learn whether there are, as I think there must be, other recorded instances of the formation of glacial rocks in the British Isles or the coasts of Europe since Pleistocene times.

January 17.

#### THE GREAT FROST OF THE WINTER OF 1890-91.

TO find a parallel to this frost for intensity and endurance, we must go back, as regards London and the south of England generally, to the severe winter of 1814, when the great fair was held on the Thames, which for long presented from bank to bank a uniform stretch of hummocky ice and snow. In that year the severity of the winter was more equably felt over the whole of Great Britain than during the present winter. Thus in 1814, the mean temperature of Gordon Castle, near the Moray Firth, for January was 27° 0, whereas during last December it was 36° 5; and, so far as records go, all parts of the United Kingdom suffered nearly alike during that memorable winter.

But during this winter of 1890-91, the contrasts of temperature in the different parts of the country from Shetland to the Channel are altogether unprecedented. In Shetland and Orkney, the mean temperature of December was about half a degree above the mean of the month for the past thirty-five years. In Caithness it was about the average, but on advancing southward the cold was the more intense, till its maximum intensity was unquestionably at Oxford, where the mean of the month was 11° below the mean of the past 35 years. The following short scheme shows generally the geographical distribution of this great frost, the first column giving the depression below the mean at places on the west coast; the second, at places in the interior of the island; and the third, at places on the east coast:—

West Coast.	Inland.	East Coast.
Barrahead ... -0° 9	Inverness ... -1° 4	Fraserburgh ... -0° 3
Skye ... -1° 2	Braemar ... -1° 8	Aberdeen ... -0° 6
Islay ... -2° 0	Glasgow ... -3° 8	St. Abbs ... -2° 8
Douglas ... -4° 4	York ... -5° 6	Spurn Head ... -4° 7
(Isle of Man) ... -4° 4	Loughboro' ... -8° 8	Yarmouth ... -5° 9
Holyhead ... -6° 0	Oxford ... -11° 0	
Pembroke ... -6° 7	Southampton ... -8° 8	Dungeness ... -8° 1
Scilly ... -4° 4		

As occurs in all low winter temperatures, the intensity of the cold is most pronounced in situations farthest

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removed from the ocean. Thus, from Oxford, the intensity of the frost was in all directions less felt. In Ireland, the intensity was pretty evenly distributed, ranging below the average from -2° 5 at Dublin to 4° 6 at Foynes and Killarney.

A very cursory examination of the weather maps of the Meteorological Office shows at once the cause of this singular difference in the degree to which different parts of Great Britain have been subjected to this frost. During the whole of this period atmospheric pressure to the east and north-east of the British Islands, notably over Russia and Scandinavia, has been unusually and persistently high, rising on occasions above 31° 000 inches; thus, so to speak, stopping the way to the usual easterly course of the cyclones from the Atlantic over North-Western Europe. Thus, in the extreme north of the British Islands, pressure has been lowered below what prevailed to the south, and consequently the preponderance of south-westerly winds has been greater. On the other hand, farther south, barometers have been almost constantly higher than they have been away still farther to southward; and be it particularly noted, low-pressure areas, or cyclones, have been almost constantly present over the Mediterranean, or even on occasions farther south, either formed over this region or drafted in from the Atlantic, with the inevitable result that the whole of Western Europe has been overspread with polar winds from north, north-east, and east, bringing with them a degree of cold which the newspaper press has been chronicling for us at our breakfast-tables day by day.

#### INDIAN ETHNOGRAPHY.

OUR Indian dependencies carry a vast field for ethnological inquiry which we have not as yet sufficiently cultivated; in fact, its importance is realized by but very few. What is really required is a systematic study of the various races of India, carried out according to a definite plan. Independent observers may do, and many have done, much; but by co-ordination more and better work can be accomplished. The Bureau of Ethnology in Washington has for its especial object the investigation and recording of all that relates to the North American Indians, and the splendid series of Reports issued by that Bureau form an invaluable mine of information on American anthropology. Is it too much to ask from our Government that we should have an analogous Bureau of Indian Ethnography? It would not suffice merely to have a department for researches on Indian ethnology, and for the publication of the results; something more than this is wanted. It would be necessary to have a library of works relating to Southern Asia, and to have an elaborately classified catalogue of books, memoirs, articles, and so forth, on every branch of Indian anthropology. Were this done, anyone who wished for information about a particular district would be able to find references to all that was known about the people, their customs, arts, and crafts. The catalogue should be a systematic bibliography, irrespective of the actual contents of the library of the institution, though every endeavour should be made to make this as complete as possible.

Such a Bureau, if properly directed, would serve as a great stimulus to those who are interested in the native races of India, but who require encouragement and direction. There can be little doubt that an immense number of isolated observations are lost for the lack of a suitable depository, the recorders of such observations being fully aware that these are too casual to be of much value; when accumulated, however, the case is very different. Were it known that a record of any obscure or rarely observed custom would be duly filed and so classified as to be readily available to anyone who was studying Indian folk-lore, the probability is that many memoranda would find their way to the Bureau which otherwise would be lost.

It cannot be too often or too strongly insisted upon that now is the time for the collection of all anthropological data in every department of that far-reaching science. To many, results are alone interesting, and there is too frequently a danger to generalize from imperfect data. Unfortunately in no department of science is it more easy to theorize than in this, and those who have not sufficiently studied the subject are often the most given to framing hypotheses which are as easy to refute as they are to make, and it is this which has brought discredit upon anthropology. Posterity will have plenty of time in which to generalize and theorize, but it will have scarcely any opportunity for recording new facts. This century has been one of most rapid transition. The apathy of our predecessors has lost to us an immense amount of information: let not this reproach be applied to us by our descendants.

The change which is everywhere noticeable is from individuality to uniformity. Religious beliefs are less varied than formerly, there are fewer local customs, there is greater uniformity in dress and personal ornament, the tools and weapons of the white man are now cosmopolitan. It is unnecessary to multiply instances: every book of travel directly or indirectly witnesses to these facts. The vulgarization of Oriental fabrics, the degeneration of Japanese art products, also testify to a levelling down, which together with a levelling up is characteristic of our modern civilization.

Every effort should be welcomed which endeavours to place on permanent record local peculiarities of any sort, and it is with pleasure we notice the too short paper<sup>1</sup> in which Herr L. H. Fischer gives the results of his personal investigations on the jewellery of the people of India and on the manner in which it is worn. As the author points out, the Hindoos are very fond of ornament: the ears, nose, neck, upper and lower arms, fingers, ankles, and

toes are adorned; but not the lips, as in some African and American tribes.

The culture and history of a people are intimately



FIG. 1.—Ear ornaments

FIG. 2.—Sinhalese ear ornament; this is very similar to an ornament common in the Solomon Islands.

interwoven, and Indian history is so complicated that India at the present time appears at first sight to be a



FIG. 3.—Silversmith.

conglomeration of races, religions, languages, and States which can scarcely be unravelled; and now this is further complicated by the introduction of European culture.

<sup>1</sup> "Indischer Volkschmuck und die Art ihn zu Tragen," L. H. Fischer, 30 pp., 51 woodcuts and 6 plates, *Annalen des k.k. Naturhistorischen Hofmuseums*, Bd. v. Nr. 3 (Wien, 1890).

At first it seems almost impossible to discriminate the typical ornaments of the separate race-stems, but in time it is discovered that the lower classes keep to traditional forms. The village smith transmits his art from father to son and grandson, always with the same archaic moulds, the same simple tools, the same designs; and it

is only the present luxury which induces fashions. The author chiefly turned his attention to the jewellery which the main mass of the people wear, and not to that of the rich, for this appears to be frequently imitated from European articles.

The material which in India is employed for jewellery is mainly silver, pure or in mixture with tin, zinc, and lead; of these, there are many alloys which constitute a gold-like metal. As a rule, yellow metal obtains in the south and white metal in the north-west, silver always predominating. In Peshawur, for example, there is hardly anything but silver. Gold is rare in India.

India possesses all known kinds of precious and less precious stones, but the polishing is as a rule very primitive. Particular provinces appear to have a predilection for stones of a certain colour; thus, in the Madras Presidency especially, green stones are almost invariably worn in the men's earrings. In Jeypore, ornaments of Indian garnets can be bought in great abundance, and the turquoise is characteristic of the Himalaya district. Naturally all kinds of stones are imitated in glass: there are glass arm-rings in South India which are principally made in Poona, Taragalla, and Surat, and are much worn. Ivory, coral, pearls, shells, and other materials are also pressed into the service of personal adornment. Bracelets made from the Changu (*Turbinella rapa*) occur in varied form in the Dacca district. The author only occasionally saw mother-of-pearl fabricated into amulets and in Ceylon into rings.

The author then goes on to describe the costume and types of ornaments characteristic of various parts of India. Numerous sketches of all kinds of jewellery illustrate the paper. There are ten representations of women from different districts scattered in the text, one of which, a Tamil from Trichinopoly, we reproduce as a specimen of the illustrations to the paper. There are also six plates of full-length portraits of women in typical costumes, three of which are in colours.

Specimens illustrative of this paper and collected by the author are to be found in the Vienna Museum. There is also in the Berlin Königliche Museum für Völkerkunde a fine collection illustrating Indian ethnography, which is arranged in a most instructive manner. Maps, photographs, and models are liberally interspersed, and the labelling is exceptionally good. Jewellery is dealt with ethnographically, and not merely as a branch of aesthetics, the use of the trinkets being illustrated by photographs and models. One thing is certain—that is, that Germans need not go further than Berlin if they desire to have an intelligent and comprehensive presentment of Indian ethnology. So firm is the conviction of Dr. Bastian, the energetic Director of the Museum, of the present necessity for gathering up the dying-away remnants of more or less barbaric and savage peoples, that he is once more on a collecting tour—this time in India—and is continually sending to Berlin cases of specimens, regardless alike of cost and space for exhibition. He feels that it is now his duty to collect, and this spirit is manifest in other departments of the Museum, notably also in one illustrative of another of our British colonies. Capt. Jacobsen is one of the best of collectors, and he has brought together an invaluable collection from North America, especially from British Columbia, the long series of grotesque dance-masks being of particular interest.

It is convenient for European ethnologists that these objects are in such an accessible Museum as that in Berlin; but we, as Englishmen, would like to see the ethnography of all our British colonies as fully represented in our own National Museum. It is true there does not at present exist any machinery for making special collections, nor was there in Berlin until enthusiasts like Dr. Bastian and others created it. There are difficulties with regard to funds and storage-room; perhaps Dr. Bastian's plan of ignoring these problems



FIG. 4.—A Tamil woman from Trichinopoly.

and of securing the specimens is not so very bad after all.

It may be urged that we already have an Indian Museum. This is true, but that collection is little more than an assemblage of specimens.

A museum has at the present day quite a different object from what it had in the past. The distinction can be put succinctly by an analogy; most of the older museums bear the same relation to modern museums that dictionaries do to text-books. Most people will admit that the perusal of lexicons is somewhat mono-

tonous and dull, and similarly the arrangement of the old class of museums was such as to give the least amount of instruction beyond the bare fact of the existence of given objects.

Large national collections should be exhaustive, and this necessitates a multiplicity of objects, but that should not preclude a scheme of arrangement which would make the specimens yield the maximum amount of information they are capable of giving. The Indian Museum affords an example of the worst style of museum arrangement.

The public has a right to expect that national specimens shall be arranged in the best possible manner, and the Government should appreciate the fact that museums, if properly conducted, afford the most interesting and vivid means for conveying instruction.

ALFRED C. HADDON.

### THE APPLICATIONS OF GEOMETRY TO PRACTICAL LIFE.<sup>1</sup>

THERE is scarcely any branch of modern science which has of recent years made such progress as geometry: there is certainly no branch over the purport of which there is so much obscurity or has been so much discussion. On the one hand, geometry, like most sciences, was born of a practical need. The Egyptians,<sup>2</sup> an eminently practical people, were not interested like the Greeks in the properties of the circle for the circle's own sake, but they wanted an art to measure the capacity of their barns and the size of their haystacks, and to plan out their pyramids and great buildings. But above all they were landowners, and to sell property they required to measure land—to measure it in square feet, and not by the time that a yoke of oxen would take to plough it, which was not always an exact or convenient test. So the Egyptians invented land-measuring or surveying, and termed it *geometry*, and the geometers they called *rope-stretchers*. Thus in the doggerel of an old textbook:—

To teach weak mortals property to scan  
Down came geometry and formed a plan.

The origin and the early applications of geometry were thus essentially due to the needs of *practical* life.

On the other hand, the Egyptians, having satisfied their immediate wants, left geometry uncultivated, and by not pursuing it on purely theoretical grounds, failed to convert it into that great instrument of investigation which in the end was to master the mystery of the heavens, guide the mariner across the trackless sea, or help the engineer to span the St. Lawrence or Douro.

The next stage in the development of geometry was left to the Greeks, for whom to apply geometry to practical purposes would have been to debase it. They studied geometry for its own sake, much as some of our friends to-day study metaphysics, only, it seems to me, they did it to more purpose. They recognized in geometry a great instrument for sharpening the intellect, and they made it the basis for a sound education. A proposition was to them a delight in itself, and to deduce a new one a distinct intellectual advance. Thus they had the proverb, "A figure and a stride: not a figure and sixpence gained."

I cannot emphasize this purely theoretical tendency of Greek geometry better than by a tale which is told of Euclid by Stobæus:—A youth, who had begun to read geometry with Euclid, when he had learnt the first pro-

position inquired, "What do I get by learning these things?" So Euclid called his slave and said, "Give him threepence, since he must gain out of what he learns."

I have said enough perhaps to indicate how the two tendencies of modern geometry, and indeed of the whole of modern science, date back to the very beginnings of scientific activity—to the practical Egyptians, whose horizon was bounded by the immediate needs of life, and to the dreamy metaphysics-loving Greeks, who despised practical applications. There are few teachers of geometry who will not have felt at times the burden of these two tendencies. The great mass of material in the form of published papers on higher geometry, many of which can only be understood by the initiated few, and some of which have probably never been read except by their writers—this weighs at times upon the mind and makes one, without despairing of science, cry, "*Cui bono?*" For whose good? How can this help the progress of mankind?" On the other hand, how the listless student, bent on struggling through life with the least expenditure of intellectual energy—how he calls up the spirit of the Greek, when he languidly asks his teacher after lecture, "What is the *use* of this? I've got the result in 'The Engineer's Pocket-book'." For him the insight to be gained by seeing the *how* and *why* of a process is of no importance, and the fingers tingle to hand him threepence that he may at least gain something by attending our lectures.

It is not my purpose now to trace these practical and theoretical tendencies through the history of geometry down to the present day. Neither do I intend to emphasize one tendency at the expense of the other. But of this fact I feel clearly and absolutely certain, that a divorce between the two—such as has existed in some of our great mathematical schools—is wholly unnatural, and tends sadly to retard the efficiency of both. What we are slowly but surely learning in this country, owing to the pressure of foreign competition, is that education and theory are needed in all branches of practical life, if we are to maintain our industrial position. But it must be education and theory which is sympathetic to practise, can indeed be wedded to it, and takes upon itself no cynical and superior airs. When we compare on the one side the vast amount of mathematical talent out of touch with all human needs, and on the other the amount of practice which limps along for want of theoretical support, we cannot but be grateful for any institution or foundation which tends to promote a better fellowship between the two. This union of theory and practice, with its offspring the applied sciences, has nowhere in recent times met with more cordial support than in the City of London. Within the last twenty years the science of engineering has been revolutionized; from an empirical and mechanical craft engineering has been raised to the rank of a learned profession. The introduction of theory into engineering practice has been largely due to the progress of modern geometry and the geometrical methods of calculation.

Problems, which when clothed in mathematical symbols only served to appal the practical man, became intelligible to him when hieroglyphics were replaced by curves upon the drawing-board. The success of this particular union of practice and theory is largely, I believe, due to the choice of a geometrical method, to the recognition that form and figure are more easily realizable by the average mind than symbol and numeric quantity.

I have referred to the union of theory and practice which has been so largely realized of late years in engineering instruction because it offers us a striking example, not only of the success of theory as applied to practice, but also of the manner in which that theory, in order to be successful, must be applied. The theory does not need to be superficial, but it must be of a kind which the practical man can grasp; the calculations must be made

<sup>1</sup> A thirty minutes' Probationary Lecture, delivered at Gresham College, on Friday, December 12, 1890, by Prof. Karl Pearson.

<sup>2</sup> The historical facts of this lecture are chiefly drawn from two excellent books—Gow's "History of Greek Geometry," and Ward's "Lives of the Professors of Gresham College."

in a form which appeals to his imagination, and in the particular sciences preliminary to the engineering profession this has been largely done by the aid of geometrical and graphical methods. Twenty years ago these methods were scarcely discovered, or the few known were neglected or scouted. To-day the most scientific Government in Europe permits the calculations and plans of the largest engineering structures which are submitted for its approval to be made by purely graphical processes. Here, then, we have an instance of theory placing at the disposal of practice one of the most efficient instruments of modern calculation and investigation, and this, indeed, is peculiarly the light in which, owing to early tradition and present needs, geometry ought, I think, to be dealt with at Gresham College. I do not mean by this that the sympathies of the City should be entirely with what we may term the Egyptian as contrasted with the Greek view of science, but solely that the City has already entered upon the labour of reconciling theory and practice, and that for a long time to come more efficient work might probably be done in this College by spreading and utilizing existing knowledge than by extending the boundaries of pure theory. The Gresham lecturer will, I fully believe, best supply existing needs, if he deals rather with the applications of geometry to practical life, than if he discourses on the more complex aspects of his subject.

I have said that this seems to me consonant with the early traditions of the College. When Sir Thomas Gresham founded this College, the old mediæval conceptions of education were dying, and modern science and modern thought were in their birth-throes. The Renaissance with its revival of learning had resuscitated the knowledge of the Greek geometry. But the minds of men were not content with pure theory; they were anxious to understand the laws of the physical universe—astrology was being replaced by astronomy, chemistry was deposing alchemy. The old forms remained, but they were filled with a new life. Sir Thomas Gresham, indeed, when he founded his College established his seven professorships on the lines of an old mediæval University, in which all knowledge was forced into one of the seven divisions—divinity, astronomy, geometry, music, law, physic, and rhetoric. But what a very different view the early science professors—those of astronomy and geometry—took of their subjects to what would have been possible a hundred years earlier! Geometry for them meant the application of mathematical knowledge to all the branches of physical science. It was not for them the pure theory of lines and circles and curves, but a process of calculating and investigating the facts of Nature. Thus the revival of geometry in the sixteenth and seventeenth centuries was on Egyptian rather than Greek lines. Newton, with astounding ingenuity, used geometry as his main instrument for investigating the motions of the moon and planets. The early occupants of the Gresham chairs of both geometry and astronomy were amongst the most distinguished scientific men of their time, especially interested in the application of mathematics to the problems of Nature and to the practical sides of life. Those were the days when England was building up a greater empire for itself on the other side of the world, and if you were to ask me what beyond their indomitable pluck carried our sailors and colonists over the Atlantic and Pacific in their frail and diminutive craft, I should reply, The labours of the Gresham professors of geometry and astronomy. It was they who published the first tables and manuals for English seamen, explained and improved the compass, the sextant, and the construction of ships. Briggs, the first occupant of the chair of geometry, wrote a work entitled, "The North-west Passage to the South Sea through the Continent of Virginia," and another entitled, "Tables for the Improvement of Navigation." It was Briggs who was mainly instrumental in introducing the use of logarithms, that most wonderful feature of modern

calculation, the use of which is imperative on every seaman and astronomer of to-day. His colleague in the chair of astronomy, Gunter (1619-26) drew up a table of logarithmic sines and tangents for the first time—a table familiar now to every navigator and land-surveyor. He was also the first discoverer of the slide-rule, now found in every architect and engineer's office, while for long his sun-dials at Whitehall remained standard time-keepers. Gellibrand, his successor (1626-36) wrote a treatise on the variation of the magnetic needle, and an "Epitome of Navigation" for seamen. No less active in this direction was Samuel Foster, who held the astronomy chair from 1641 to 1652. He explained the use of the quadrant for finding position at sea, and wrote more than one work bringing home the results of theory to the seventeenth century seamen. Lawrence Rooke, who successively held the chairs of astronomy and geometry, published "Directions for Seamen going to the East or West Indies to keep a Journal." To Sir Christopher Wren, who was Gresham professor from 1657-60, there is no need to make any reference in the City. His practical applications of theory are well known; that he published books on navigation and the structure of ships, that he first gave a theory of the pendulum, and improved the telescope, is perhaps less generally remembered. In his days there was a scientific enthusiasm at Gresham College which we can hardly realize anywhere now. Wren, we hear, had special charge of the planet Saturn, and his colleague Rooke of Jupiter, and their observations and lectures turned on the great discoveries then being made with regard to these peerless chiefs of the solar system.

But perhaps the most brilliant of the Gresham professors was Robert Hooke, who held the chair of geometry from 1665 to 1703. He also published "Directions for Seamen"; he delivered and afterwards published "Lectures for improving Navigation and Astronomy." But more than all he invented the watch, with the declared object of measuring time at sea, where no pendulum clock could be of service. The first account of the construction of the watch was given by the Gresham professor of geometry in his lectures at the College on "Several new Kinds of Watches for the Pocket wherein the Motion is regulated by Springs." Hooke improved also the reflecting telescope; he invented a marine barometer, and several new kinds of lamps. He wrote a treatise on the sails of windmills. He laid the foundation of the modern science of elasticity, and made the earliest researches of scientific value on the strength of materials. After the Great Fire of London, Hooke, like his former colleague Sir Christopher Wren, presented a model for the rebuilding of the City. Indeed, it is no exaggeration to say that in the seventeenth century it was to the Gresham professors that practical men seeking help from theoretical science naturally turned.

I might, had I the time at my disposal, bring still further evidence to show that the earliest of Sir Thomas Gresham's lecturers were essentially occupied with the applications of science to practical life, and that this tradition lasted so long as the post of Gresham lecturer meant in itself one of the highest distinctions in the land. But I can only now refer to one fact from which in itself a true idea of the original activity of Gresham College might be formed. Gresham College was the cradle of the Royal Society. It was within its walls, and notably within the rooms of the professor of geometry, Lawrence Rooke, that the makers of England's earliest scientific reputation, men like John Wallis, Robert Boyle, and Lord Brouncker, together with the Gresham professors, Christopher Wren, Robert Hooke, and Sir William Petty, used to meet to discuss experiments, and it was at Gresham College that they received their charter of incorporation as the Royal Society in 1662.

A French traveller, who visited England in the year

1663, and whose diary has recently been republished, gives us an account of several visits to the Royal Society's meetings at Gresham College:—

"On May 23," he writes, "I was at the Academy of Gresham, where every Wednesday an assembly is held to make a variety of experiments upon matters not yet fully understood, but which are described according to each one's knowledge, while an account of them is written out by the secretary. The President, who is always a person of quality, is seated at the top of a great square table, and the secretary at one side. The Academicians are seated on benches running round the hall. The President is Lord Brouncker, and the secretary is Mr. Oldenburg. The President has a little wooden hammer in his hand, with which he strikes the table to call to silence those who want to speak when another is speaking; thus there is no confusion or clamour.

"It was reported that salt of tartar put upon toads, vipers, or other venomous beasts caused them to die; some one said that quicksilver had the same effect; that these animals could not live in Ireland, as they could not bear the soil, and that experiments had been made by putting them on soil brought from England along with the animals; when they thought to escape, and approached the soil of the country, they always had to turn back, and did this until they died. Further, that a branch of holly placed in a certain lake in Ireland, in such wise that a part was in the earth, a part in the water, and a part in the air, after some time—a year or thereabouts—changed its nature; the part in air remained indeed wood, but that in the water became petrified, and that in the earth metallic in character. . . . In order to procure in ponds fish of all sorts which are difficult of transport, it is only necessary to carry the eggs of the fish one requires, and these will afterwards hatch out; this a lord from Ireland said he had put into practice. Further, it was noted that the germination of insects does not arise from decay; for the intestines of an animal and other parts which easily corrupt having been placed in a glass closed with cotton-wool, so that no fly or other animal could enter, but only the air could penetrate, they had been preserved for six weeks without maggot or other thing being observed. . . . Bodies weighed in the air had been afterwards weighed in a very deep pit, and had been found to weigh one-sixteenth less. That bodies which sunk in water came up again when one put more water into the vessel, which proved the compression of water by water. . . . Sir Robert Moray told me that the President wished to give to the public a new science of the movement of bodies in water, and so to improve the art of navigation; with this end in view he was experimenting on the ease with which bodies of diverse shapes moved through water. . . . That a method of learning the difference of weight of various liquids was to weigh in them a body attached by a fine thread of silver or other metal, and the difference of the weights of this body enabled one to estimate the weights of the liquids.

"The meeting concluded with the exhibition of a number of experiments made with an air pump invented by Robert Boyle."

Some of these experiments may sound strange to modern ears trained to a more scientific view of natural phenomena; but their general drift is in the right direction, and their bearing on the needs of every-day life sufficiently obvious to warrant us in asserting that it was in Gresham College and around its professors that in the seventeenth century those interested in the practical and experimental sides of science collected. I believe that the dignity and importance of the College in its early days were largely due to its being closely in touch with the wants of practical life. I have no wish to minimize the educational value of purely theoretical science. I

recognize how great a factor it has been and is in the intellectual and spiritual growth of the nation. Investigations like those of Darwin and Maxwell, which appear at first sight to have no practical applications, may profoundly alter our whole view of human life, or of the physical world which surrounds it, and in doing this may modify indefinitely our practical conduct or our command of the forces of Nature.

Even geometry in its more abstruse speculations, when it transcends the space in which we live and theorizes of another, of which ours is as poorly representative as a landscape painted on flat canvas is poorly representative of the wealth of form and distance in the scene it depicts—even this abstruse geometry may some day react on practical life, by the modifications it is capable of producing in the current ideas of space and force. I recognize to the full this educational value in geometry, and in all forms of pure science; but I believe that there are other institutions—notably the great Universities—which sufficiently emphasize this side of learning. On the other hand, I think that there is a gap which Gresham College is well suited to fill, and I believe that to fill it would not be out of accordance with its early traditions. By this gap I understand the want of an institution which, while recognizing the educational value of science, would mainly devote itself to pointing out, in a popular manner, the bearing of the conclusions of modern science on practice and the applications which can be made of them to ordinary life.

In particular, it seems to me that the lectures on geometry can be made especially serviceable in this direction, if geometry be interpreted in the wide sense current in the seventeenth century, and which it retains to this day in France. The modern development of graphical and geometrical methods has placed a powerful instrument of calculation and investigation in the hands of those who have neither the time nor opportunity of learning to handle the abstruse tools of analytical mathematics. Wherever quantity of any sort has to be measured and reasoned upon, there these geometrical methods find their applications. Their applications are indeed so manifold that it is difficult to enumerate them: to questions of force and motion, to problems in the strength of materials, in the structure of bridges and roof-trusses, of machinery in motion, of cutting and embanking—they have been long applied, and form the basis of much of modern engineering practice. But there are other fields which would constitute more suitable topics for a Gresham lecturer. The graphical representation of statistics at once suggests itself. Mortality, trade, goods and personal traffic, furnish statistics which if dealt with in a graphical manner very often suggest conclusions which are of the greatest interest to those dealing with problems of insurance and commerce—conclusions more readily deducible from the geometrical than from the numerical representation of statistics. What may be achieved in this direction is admirably illustrated by the graphical album of trade returns published annually by the French Government. The like geometrical methods have in recent years been applied to the principles of political economy, till the theory of prices has become almost a branch of applied geometry.

But it is not alone in these very specialized subjects that we may reason geometrically. The whole field of physical science is occupied with the investigation, representation, and reasoning upon *quantity*, and therefore is essentially a field for the application of geometrical methods, but the bearings of physical science on practical life are too wide and too well known to be enlarged upon now. I had intended originally to take to-night some single point in this field, and explain how geometry might be used to elucidate it; but on second thoughts it seemed to me probable that the geometrical preliminaries would have absorbed all the time at my disposal, and that ac-

cordingly I might with more advantage lay general stress on the importance of the practical applications of geometry. In doing this, I have possibly had the future of Gresham College more in view than my own candidature for the lectureship in geometry.

But I believe that, quite apart from the present election, the College has a future worthy of its earliest days, and that, not improbably, this future, if in another field, will still lie within the same broad lines that the City has already laid down for itself in the matter of technical education, the motto of which I take to be: Practice enlightened by theory, theory guided by practical needs. Work on such lines as these, accompanied by the expansion due to modern scientific requirements, would, I fully believe, restore the College to something like its old position among the teaching bodies of London, and reverse the judgment of that Cambridge historian of mathematics who has recently remarked that, "with the beginning of the eighteenth century, an appointment at Gresham College ceased to be a mark of scientific distinction."

#### THE PHOTOGRAPHIC CHART OF THE HEAVENS.<sup>1</sup>

THE publication of the fifth fasciculus brings us within reasonable distance of the actual commencement of the celestial chart, and the centre of interest is shifted from the theoretical speculations which have characterized the earlier publications to the more practical details suggested by the employment of the photographic instruments in those Observatories which are now equipped for the undertaking.

After three years of anxious organization, Admiral Mouchez sees the goal for which he has laboured so strenuously well in view. We may offer him our congratulations on what may be regarded as the completion of the first, but not the least arduous, portion of the task he has undertaken. He has succeeded in binding together, with a common aim and with unity of purpose, the astronomical energies of various nationalities, and, mainly through his exertions, the reputation of many Observatories stands pledged to complete the scheme which he has originated.

That great tact and delicacy have been necessary to carry the initial proceedings to a successful issue will be readily granted. Possessed as the French were with the typical photo-telescope, it would have been possible—nay, it might have been expected—that the Paris astronomers would have conducted a series of inquiries and experiments which would have enabled them to insist upon the exact arrangement of many details, and thus practically to exclude the judgment and participation of those Observatories whose equipment was less complete. But, with a delicacy which some might think almost to border on indifference, the French astronomers have nowhere taken advantage of the early possession of their photo-telescope to enable them to anticipate the researches of their collaborators. This policy of affording a fair start to the many participants will prevent any step of real practical importance in the actual photographing of the zones being undertaken till after another general Conference has met and deliberated. The invitations for this Conference have been issued for March next.

But if the French astronomers have been willing to efface themselves to some extent, in order to advance the scheme in which they are so much interested, it must be admitted with gratitude that they have been at all times willing to submit to various astronomers negatives, taken with the Paris instrument, for the discussion and decision

of questions of the first importance. In this connection we may notice the valuable discussion on photographic images, and the accuracy of their measurement at considerable distances from the centre, due to Prof. Bakhuysen. To the same astronomer, and again employing materials placed at his disposition by the Paris authorities, is due a valuable paper on the actual measurement and determination of the co-ordinates of 341 stars, with the comparison, wherever possible, with meridian observations; thus affording a practical measure of the accuracy likely to be attained in the catalogue places deduced from the measured negatives.

These and other inquiries of scarcely less interest and importance have appeared in the earlier fascicules published under the auspices of the Permanent Committee. One of the aims of this Committee appears to have been to collect in one convenient summary the whole of the literature which bears on the question of the photographic chart. Consequently, many papers which have appeared from time to time in other periodicals are reproduced here, either complete, or as abstracts. To these papers no reference need now be made. It will, however, be a matter of sincere regret to many astronomers, that no account is given of the experiments which, it is understood, have been carried out by Dr. Eder, under the auspices of the Committee. These experiments were undertaken with the view of determining the best method of preparing and developing the sensitized plates to be used in the chart. The results of an investigation conducted by so able and experienced a photographer as Dr. Eder were expected with considerable interest; and the omission of any reference to his results is the more to be regretted, since it was announced in September 1889, that the experiments were complete, and that the manuscript giving details would be forwarded to Paris in a fortnight. We may hope that the absence of any reference to Dr. Eder's work is caused by a simple delay, and does not indicate an abandonment of the inquiry.

Among the original papers which add an importance to the fifth fascicule are two contributed by the Astronomer-Royal, and which mark a distinct progress in the settlement of the preliminary details. In the first of these are reported the conclusions arrived at by a Committee appointed to consider the method of choosing the co-ordinates of the centres of consecutive plates. The problem the Committee had to solve was, how to fit, with the least possible loss of plates, and with the greatest convenience to the observer, a series of square plates to the concave surface of a sphere. It is evident that, as the declination increases, very different angles of right ascension are covered by the plate, and that even on the same plate, since the side covers  $2^\circ$ , the top and bottom of the plate will not occupy the same arc of right ascension. At  $45^\circ$  declination, the northern edge of the plate will correspond to six minutes more of R.A. than the southern, and of course, at greater declinations, the want of uniformity in this respect becomes more and more marked. The difficulty is not diminished by a decision of the Permanent Committee, that a second series of negatives should be taken, in which a corner of the plate in the first series should be made to coincide with the centre of a plate in the second series. Under these circumstances, the Committee submit two slightly different schemes. In either of these methods the centre of the plate will be made to correspond to the beginning of a minute of right ascension.

But to maintain this convenient rule, and at the same time adhere rigorously to the recommendations of the Conference, it would be necessary to arrange the zones photographed in such a manner that the breadth of the zone should be such that an arc of  $2^\circ$  of a great circle covers an even number of minutes of R.A. The Committee therefore contemplate the possibility of slightly relaxing the decisions of the Conference, and to so arrange

<sup>1</sup> "Bulletin du Comité International Permanent pour l'Exécution Photographique de la Carte du Ciel." Cinquième fascicule. (Paris: Gauthier-Villars et Fils, 1890.)

the zones that, when an odd number of minutes of R.A. is covered in the first series, it shall no longer be necessary to commence the second series at the half-minute, which would insure the exact coincidence of the corner of the first plate with the centre of the second, but to make the co-ordinates of the centre of each plate in the second series correspond to the nearest minute, midway between the extreme times covered on the first plates. The advantage of the alternative scheme proposed by the Sectional Committee is that a smaller number of plates will be required to cover the heavens. To photograph the whole sphere twice over with plates each of which accurately delineates four square degrees, and the sides of which nowhere overlap, would require 20,802. If the project of the "even minutes" and the recommendation of the Permanent Committee be strictly enforced, the number of plates required is 22,474; but if the alternative scheme of the Sectional Committee is adopted, this number is reduced to 22,054. The scheme founded on the employment of the mean minute is drawn up in detail, and seems to leave nothing to be desired, and it is sincerely to be hoped that the Permanent Committee will see their way to modify the resolution to which they have already agreed.

It is doubtful, however, whether the Committee will appreciate the advantage of reducing by about 2 per cent. the number of plates to be taken, involving as it does a reconsideration of their recorded decision. On another matter, there is exhibited a stout determination to uphold the resolutions in their integrity; and the spirit of loyalty to the decisions of previous Conferences may outweigh the expediency of reducing the labour of taking the negatives. In another paper the Astronomer-Royal has been bold enough, on sufficient grounds as it will no doubt appear, to recast the arrangement of the zones allotted to the participating Observatories. This proposed alteration has already called forth a protest against any change in the resolutions already carried. Admiral Mouchez, however, is adverse to a blind adherence to those early decisions. Infallibility, he remarks, does not obtain in science, and he advises the Permanent Committee to retain in its own hands any powers of modification and correction which may assist the onward progress of the work. The propriety of such a course seems to go without saying. It could never be sufficiently regretted if the decisions of immature experience limited and controlled the proposals of ripened judgment and more extended practice.

In the remaining portion of the fascicule, the subject of magnitudes is treated at considerable length, and from various points of view. Several resolutions have been adopted with the view of securing on the negatives, from which the catalogue is to be deduced, the images of stars of the eleventh magnitude; and in order that there may be no elasticity about the term "eleventh magnitude," it is proposed that the scale of Argelander shall be prolonged beyond the ninth, by increasing the time of exposure in the same ratio at which the light of a star diminishes between successive magnitudes of Argelander's scale, namely 2.5. It seems to have been the intention of those responsible for the application of this principle, that each observer is required to determine the time necessary to secure an image of a ninth magnitude star, and to prolong the exposure for the tenth and successive magnitudes by the continued employment of the coefficient 2.5. Whether this be the appropriate coefficient to ensure the reproduction on a negative of stars of a definite degree of brightness, as recorded by photometric methods, is open to question. A still larger coefficient necessitating longer exposures has been suggested, and further experiments in this direction are much needed. But admitting the theoretical accuracy of the scheme, its practical realization is surrounded with many difficulties, and while acknowledging the laudable effort on the part of the Com-

mittee to secure a strict uniformity of magnitude on the plates, it is doubtful whether, without some supplementary aids to observers, the surest method has been taken of carrying that intention into effect.

Foreseeing some difficulties in realizing the aim of the Committee in this direction, M. Trépied has proposed to construct, and to put into the hands of observers, photographic types of stars of the eleventh and fourteenth magnitude, in order that they may convince themselves after the development of a negative, that the prescribed limits of magnitude have been reached with a sufficient degree of approximation on each plate. He proposes to obtain, by photographing in various parts of the sky, an average conventional type of the photographic images of stars of the ninth, eleventh, and fourteenth magnitudes, all based upon the time in which the ninth magnitude star can be photographed. It will therefore only be necessary, he conjectures, for the observer to compare the images of the ninth magnitude star, when, if a similarity of appearance with the normal type results, it may be inferred that stars of the fainter magnitudes will be visible. It is a practical attempt to solve a difficult problem, and it is to be hoped the method may have a fair trial.

It is here presumed that the scale of magnitudes which obtains in photometry will be prolonged as far as the fourteenth magnitude. This point, however, has not been definitely settled by the Committee, and there are not wanting astronomers, of whom Prof. Holden is the principal exponent in this volume, who are in favour of an entire reconstruction of the system of magnitudes now in vogue, and for which this great undertaking, inaugurated under the auspices of Admiral Mouchez, offers an opportunity which is not likely to occur again.

W. E. P.

#### NOTES.

THE Chemical Society, having been founded in 1841, is in the fiftieth year of its existence and is the eldest among Chemical Societies. To celebrate this important occurrence in the history of the Society, it has been arranged that on February 24, at 3-5 o'clock p.m., a meeting shall be held at the Society of Arts, where the original meeting took place on February 23, 1841, at which the formation of the Society was decided on. At this meeting various addresses will be delivered, and delegates from other Societies will be received. On the evening of the same day, at 8.30 o'clock, the President and Council will hold a reception at the Goldsmiths' Hall, which has been most kindly placed at the disposal of the Society for the purpose by the Worshipful Company of Goldsmiths. On the evening of February 25, at 6.30 for 7 p.m., the Fellows and their friends will dine together at the Hôtel Métropole.

THE changes consequent on the retirement of Prof. Oliver, the late Keeper of the herbarium and library in the Royal Gardens, Kew, have now been completed. Mr. J. G. Baker, F.R.S., the Principal assistant, becomes Keeper; Mr. W. B. Hemsley, F.R.S., the Assistant for India, becomes Principal assistant; and Dr. Otto Stapf, Privat Dozent in the University of Vienna, Assistant for India. Mr. Hemsley is well known in the botanical world as the author of the botanical part of Godman and Salvin's "Biologia Centrali-Americana," of the Report on the Botany of the *Challenger* Expedition, and of the "Index Floræ Sinensis" still in progress. Dr. Stapf is the author of a monograph on *Ephedra*, and has travelled for botanical purposes in Persia.

THE Bentham Trustees have secured the services of Prof. Oliver as consulting botanist; he will also edit Hooker's "Icones Plantarum," which is now published for the Trustees under the authority of the Director of the Royal Gardens.

PROF. HELMHOLTZ will reach his seventieth birthday on August 31. Some of his very numerous friends and admirers will take advantage of the occasion to present him with a mark of their esteem. The details are to be settled by a Committee, consisting of Profs. Hofmann, Du Bois-Reymond, Virchow, and others.

THE *Times* of January 21 publishes an excellent letter by Prof. W. E. Ayrton on the proposed South Kensington and Paddington Subway Railway, to which we have repeatedly called attention. During the last few weeks Prof. Ayrton and Prof. Rücker have been taking measures to ascertain the magnitude of the disturbance that would be caused by the subway railway if constructed along the proposed route. They did not employ any very delicate instruments, such as are necessary for physical research, but only the ordinary rough apparatus that is in daily use by students in a modern physical laboratory. Even such rough apparatus is seriously affected by mechanical vibration, and they have been led to the conclusion that the earth waves produced by the passage of large weights at high speeds affect measuring apparatus far more seriously than the noisy street traffic that rattles the windows of a house.

THE death of Dr. Henry Bowman Brady, F.R.S., is announced. He died a few days ago at Bournemouth, in his fifty-sixth year. Dr. Brady was the author of many important memoirs on the Rhizopoda and other minute forms of invertebrate life. He was a Fellow not only of the Royal Society but of the Linnean and Geological Societies.

THE Council of University College have arranged for a series of free evening lectures during the present term. One lecture will be given every week. On March 11, Prof. W. Ramsay will lecture on "Ice, Water, and Steam." A lecture on "The Universities of Egypt: Heliopolis, Alexandria, and Cairo," will be delivered by Prof. Stuart Poole on March 25.

ON Monday evening, at the meeting of the Royal Geographical Society, Dr. Alexander Buchan read a paper on the meteorological results of the *Challenger* Expedition in relation to physical geography.

DR. WILLIAM CROOKES delivered his presidential address before the Institution of Electrical Engineers on Thursday, January 15, taking as his subject "Electricity in transitu: from plenum to vacuum." In his introductory remarks he explained that he was about to treat electricity, not so much as an end in itself, but rather as a tool, by whose judicious use we may gain some addition to our scanty knowledge of the atoms and molecules of matter, and of the forms of energy which by their mutual reactions constitute the universe as it is manifest to our five senses. Explaining what he meant in characterizing electricity as a tool, he said that, when working as a chemist in the laboratory, he found the induction spark often of great service in discriminating one element from another, also in indicating the presence of hitherto unknown elements in other bodies in quantity far too minute to be recognizable by any other means. In this way, chemists have discovered thallium, gallium, germanium, and numerous other elements. On the other hand, in the examination of electrical reactions in high vacua, various rare chemical elements become in turn tests for recognizing the intensity and character of electric energy. Electricity, positive and negative, effect respectively different movements and luminosities. Hence the behaviour of the substances upon which electricity acts may indicate with which of these two kinds we have to deal. In other physical researches both electricity and chemistry come into play simply as means of exploration.

THE annual general meeting of the Anthropological Institute of Great Britain and Ireland will take place on Tuesday, the

27th inst., at half-past 8 o'clock p.m. The chair will be occupied by Dr. John Beddoe, F.R.S., President, who will deliver an address.

THE seventeenth general meeting of the Association for the Improvement of Geometrical Teaching was held at University College on January 17. Prof. J. J. Sylvester, F.R.S., was elected President for 1891. The following were chosen as Vice-Presidents: R. B. Hayward, F.R.S., Mr. R. Levett, Prof. G. M. Minchin, and Mr. R. Tucker. Papers were read by Miss Wood, on the use of the term "abstract" in arithmetic, and by Mr. E. T. Dixon, on the foundations of geometry; and Mr. E. M. Langley read some notes on statics and geometry. A petition prepared by the Decimal Association, urging the prompt introduction into the United Kingdom of a decimal system of coinage, weights, and measures, was signed almost without an exception by the members present.

THE Paris Société de Biologie has elected, as Presidents for 1891, MM. Charles Richet, editor of the *Revue Scientifique*, and Malassez, the able histologist of the Collège de France.

M. BONVALOT, the explorer of Tibet, is to deliver an address on his travels, at the meeting of the Paris Geographical Society on January 31.

MESSRS. MACMILLAN will issue immediately "Outlines of Psychology," a translation, by Miss M. E. Lowndes, of the well-known work by Prof. Höfding, of the Copenhagen University. The translation is from the German edition, but this has been accepted by Dr. Höfding as adequately representing the Danish original. The book is thoroughly scientific in method, the author regarding it as the task of psychology to investigate simply the phenomena of mind, not to deal with metaphysical explanations. He examines systematically the psychology of cognition, of feeling, and of the will, and has many suggestions to offer as to the relations between his special subject and physiology.

A CORRESPONDENT writes from Edinburgh:—"We have had a wondrous sight here for the past few days—thousands of sea-gulls flying about the Botanic Garden. I have seldom seen so many together even at a nesting resort. One naturally supposed stormy weather at sea had driven them in, but no, it is a land storm which has occasioned their visit. One of the railway companies owns a bit of waste land near, and thither have been conveyed the tons upon tons of Christmas presents gone wrong in the hands of the company in consequence of the strike, and these are now being devoured by the gulls."

THE Kew Committee have issued their Report for the year ending October 31, 1890. The usual meteorological and magnetical summaries are omitted, and it has been decided to present them in future to the Royal Society as soon after January 1 as possible. Nearly 20,000 instruments of various kinds, mostly clinical thermometers, were compared in the past year, and over 500 entries of watches for rating were made. Sketches of sunspots were made on 198 days, and the groups numbered after Schwabe's method. Among the various experiments carried on may be mentioned an ingenious method, suggested by General Strachey, for determining the height and velocity of clouds. Photographs by means of two fixed cameras are taken simultaneously of the area of the sky surrounding the zenith within a circle of a radius of about 15°. The pictures are afterwards carefully superposed, and a simple measurement of the distance between the images of the zenith points, which are marked by intersecting lines, gives a means of readily determining the height of the cloud. A second measurement of the displacement of the zeniths from photographs taken after a given interval shows the rate and the direction of movement of the cloud. Twenty groups of clouds, giving heights extending from 1½ to 8 miles, and rates of motion

from 5 to 64 miles an hour, have been photographed and measured during the past summer. No very exceptional magnetic disturbances were recorded at the Observatory during the year; the principal disturbances occurred on November 1 and 26-28, 1889.

THE great anticyclone which was situated over Europe and embraced the greater part of this country during December last made that month, as a whole, about the coldest December of any on record over the southern part of England. It is seen from the Pilot Chart of the North Atlantic Ocean that the storms of December were confined almost entirely to the Atlantic coasts of the continent of North America. None of the depressions were able to force a passage through the anticyclone, and very few of them passed to the eastward of longitude  $40^{\circ}$  W. within the area of observation. The Pilot Chart shows that the very severe storm that passed close to Cape Race on November 29 was followed two days later by a hurricane, said to have been the most severe that has been experienced in the Gulf of St. Lawrence for sixty years. Many observers reported hurricane force; and the barometer fell to  $27.95$  inches on December 1. There was also a severe storm off St. John's, Newfoundland, on the 8th, and others near Hatteras on the 16th and 26th. A large iceberg (estimated to be half a mile long) was seen on December 13, in lat.  $49^{\circ} 39'$  N., long.  $47^{\circ} 50'$  W. A supplement to the Pilot Chart shows the positions of the ice in the North Atlantic for each month from December 1889 to November 1890—none of the months being entirely free from ice.

To enable the Indian Observatories Committee at home to judge of the amount and nature of the work done at the Madras Observatory, the Government Astronomer has been instructed, says the *Times of India*, to prepare in future detailed and technical reports, unlike the present reports submitted to the Government, which, though called administration reports, contain nothing of interest or value to the scientific public.

THE New York *Engineering and Mining Journal* says of a Bill before Congress making an appropriation of 100,000 dollars for a topographical survey of the Territory of Alaska, reported in September by the House Committee on Military Affairs, that "the proposal made in the Bill is to send out a properly-equipped party with instructions to establish a post on the Upper Yukon River, and to operate therefrom in all directions. This territory of more than 600,000 square miles has been in the possession of the United States for twenty-three years. Nevertheless its interior is less known than the centre of the African Continent. The surveys which have been conducted near the coast have been imperfect, and of but little practical value. The Canadians have done much more in making explorations in and surveys of the Alaska frontier than we have; they invited us to join them in the work some years ago. These facts reflect no credit upon a nation of 63,000,000 of progressive people possessing an overflowing Treasury. The region should be surveyed, and its resources of all descriptions ascertained. The Bill, designed to furnish the means to such an end, should become a law."

EARLY this year an expedition, under the leadership of Dr. C. von Drygalski, of Berlin, will start for the west coast of Greenland, to examine the condition of the ice.

DIRECTOR SCHERENBERG, late of Grohn, has presented a collection of over 800 of the birds of North Germany to the Bremen Natural History Museum.

FROM Janjici, near Zerica, in Bosnia, is reported an earthquake, which occurred on January 5 at 8h. 2m. p.m. The eruption was exceedingly violent, lasting for three seconds, and being accompanied by subterranean noises. On January 7 a violent shock was experienced at Granada.

DESPATCHES received at New York from Mexico City announce that five shocks of earthquake occurred on January 17, at Jacula, in the State of Hidalgo, Mexico.

ACCORDING to a telegram from Algiers, the villages of Gouraya and Villebourg have been almost wholly destroyed by an earthquake, and about forty natives have perished. The damage done to property is estimated at half a million francs.

SOME alarm was caused at Geneva, on January 20, at 4 a.m., by slight shocks of earthquake which were distinctly felt there. On the same day, several shocks were felt at Belfort.

IN February 1890, the Island of Bogoslaw (37 nautical miles north-west of Unalaska), in the Behring Sea, was disturbed by a volcanic eruption, which created three small islands in its immediate vicinity. The island itself was raised 1000 feet, and the flames accompanying the outbreak were visible on Mount Macushin (5500 feet). The ashes collected at Ililiuk, in Unalaska, contained a considerable percentage of magnetic ore.

THE following report from the Professor of Geology in the University of Oxford, on the results of the geological work during the last summer meeting, has been published:—"The interest in the subject was well kept up, and the amount of systematic study was somewhat larger than during 1889. The increase in this direction was not large, but quite large enough to be sensible. I have received letters from students who worked with me both in 1889 and 1890, saying how their visit to Oxford gave stimulus and encouragement to them to carry on at home work they had begun here, and how greatly even the small amount of instruction they received here helped them in their further studies. One young lady who knew scarcely anything of geology when she came to me in 1889, and to whom I gave occasional help and advice for home reading, after she left Oxford obtained a first class medal in geology at the St. Andrews examination for women, in January last."

CAPTAIN DE PLACE, of Paris, has invented an instrument for detecting flaws in metal castings and forgings, which is called the scisèophone. According to the *Times*, the apparatus consists of a small pneumatic tapper worked by the hand, and with which the piece of steel or iron to be tested is tapped all over. Connected with the tapper is a telephone with a microphone interposed in the circuit. Two operators are required, one to apply the tapper, and the other to listen through the telephone to the sounds produced. These operators are in separate apartments, so that the direct sounds of the taps may not disturb the listener, whose province it is to detect flaws. The two, however, are in electrical communication, so that the instant the listener hears a false sound he can signal to his colleague to mark the metal at the point of the last tap. In practice the listener sits with the telephone to his ear, and so long as the taps are normal he does nothing. Directly a false sound—which is very distinct from the normal sound—is heard, he at once signals for the spot to be marked. By this means he is able not only to detect a flaw, but to localize it. Under the auspices of the South-Eastern Railway Company, a demonstration of the scisèophone was given last week by Captain de Place, at the Charing-cross Hotel, in the presence of several members of the Ordnance Committee and other Government officials. Mr. Stirling, the company's locomotive superintendent, had previously had several samples of steel, wrought iron, and cast iron prepared with hidden flaws known only to himself. The first sample tested by Captain de Place he pronounced to be bad metal throughout, which Mr. Stirling stated he knew it to be. Other samples were tested, and the flaws localized by means of the apparatus. On some of the bars of wrought and cast iron being broken, the internal flaws—the localities of which were known to Mr. Stirling by his private mark—were found to have been correctly localized by Captain de Place. On the

other hand, some bars were broken at points where the apparatus indicated a flaw, but where the metal proved to be perfectly sound; so that the apparatus is not yet quite trustworthy.

M. JULES RICHARD has recently discovered in the two lakes of the Bois de Boulogne, Paris, numerous specimens of hitherto unknown Crustaceans. Among the strangest "finds" of this zoologist is that of a new species of the Copepod genus *Bradya*, the *B. edwardsi*. This species is a blind one, and is the only species of the genus hitherto found in fresh water. *B. typica* was discovered in a fjord near Christiania, another one was found off the Scilly group, and *B. limicola* lives in brackish waters at Ocean Springs (Mississippi). Facts go to show that this fresh-water species is of subterranean origin, as it comes, or seems to come, from the water of the artesian well at Passy, which is sent to the Bois de Boulogne lakes. Both of these lakes are swarming with a large variety of Entomostraca.

WE learn from the quarterly statement of the Palestine Exploration Fund that the famous "Siloam inscription" has been cut out of its place in the rock tunnel and carried away. It was broken in removal, and the fragments are reported to have been sold to a Greek of Jerusalem. On receiving this intelligence, the Executive Committee of the Fund forwarded to Hamdi Bey a resolution expressing their regret, and the hope that immediate steps would be taken to secure the fragments. Fortunately an accurate copy of this inscription had been made, and published by the Fund. The occurrence, as the Committee claim, shows how valuable the work done by the Fund has been in preserving records of monuments which are in daily danger of being destroyed.

THE Committee of the Palestine Exploration Fund are about to issue "Fauna and Flora of Sinai, Petra, and the Wady 'Arabah," by Mr. H. Chichester Hart.

THE third volume of the "Educational Annual" has been issued. The work has been carefully revised, and the statistics have been brought down to date from the public records.

M. ROUZAUD, of the Montpellier Faculty of Sciences, has issued a handsome volume recording the principal incidents connected with the celebration of the 600th anniversary of the Montpellier University last June.

THE new number of the Journal of the North China Branch of the Royal Asiatic Society will, according to a recent announcement of the Secretary, open with a valuable paper, the result of many years' research and of much study by a ripe scholar, Dr. Bretschneider. It is styled "Botany of the Chinese Classics," and is, in fact, a continuation of the studies condensed in a paper by the same author, which appeared, under the title "Botanicon Sinicum," in the Journal some ten years ago. The manuscript has arrived safely from St. Petersburg, and is in the printers' hands. The paper will have the benefit of revision and annotation by Dr. Faber, a high authority on botanical subjects; and thus it will doubtless serve as an extremely valuable work of reference. Dr. Bretschneider is at work on another paper—which, however, it is feared, will not be ready for some years—on Chinese medicines.

A NEW series of well-crystallizing salts of iridium-ammonium have been prepared by Dr. Palmaer in the laboratory of the University of Upsala, and are described by him in the latest number of the *Berichte*. They are pentammonium salts corresponding to the well-known *purpureo* compounds of cobalt, chromium, and rhodium. The chloride,  $\text{Ir}(\text{NH}_3)_5\text{Cl}_2$ , is readily obtained by the action of ammonia upon the tri- and tetra-chlorides of iridium. It crystallizes in beautiful rhombic pyramids, completely isomorphous with the *purpureo* cobalt and rhodium chlorides. Usually the crystals possess a deep ruby-red colour, but this is found to be due to a trace of iridium-ammonium

chloride, and by other modes of preparation crystals may be obtained which are merely pale yellow in colour. It is interesting that only two of the three chlorine atoms are removable by means of strong sulphuric acid or silver nitrate, the third chlorine atom, as in case of the cobalt and rhodium salts, being much more tenaciously held. The product of the action of sulphuric acid is consequently the salt  $\text{Ir}(\text{NH}_3)_5\text{ClSO}_4$ , which crystallizes in bright yellow monoclinic crystals, possessing extraordinarily large double refraction. When the solution of this salt is mixed with solutions of barium bromide and iodide respectively, rhombic crystals of the salts  $\text{Ir}(\text{NH}_3)_5\text{ClBr}_2$  and  $\text{Ir}(\text{NH}_3)_5\text{ClI}_2$  separate out; these crystals are strictly isomorphous with those of the original trichloride, and the angles are very nearly identical. The tribromide,  $\text{Ir}(\text{NH}_3)_5\text{Br}_3$ , was obtained from the trichloride by boiling the latter with soda, and afterwards treating in the cold with concentrated hydrobromic acid which precipitated a roseo-bromide; the filtered roseo-bromide was found to be readily soluble in dilute hydrobromic acid, and the solution yielded the pentammonium tribromide on gently warming in the form of yellow crystals, also isomorphous with the trichloride. The salt  $\text{Ir}(\text{NH}_3)_5\text{BrSO}_4$  was also prepared, sulphuric acid being incapable of removing the third atom of bromine, which, like the third atom of chlorine, is evidently combined in an unusually stable manner. In addition to the preparation of these salts, the hydrate,  $\text{Ir}(\text{NH}_3)_5\text{ClOH}$ , has also been obtained as a strongly alkaline solution, which absorbs carbon dioxide, and is capable of expelling ammonia gas from sal-ammoniac.

THE additions to the Zoological Society's Gardens during the past week include a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. E. Hopkinson; two Large Hill-Mynahs (*Gracula intermedia*) from Northern India, deposited; a Red Lory (*Eos rubra*) from Moluccas, purchased.

#### OUR ASTRONOMICAL COLUMN.

STARS HAVING PECULIAR SPECTRA.—In two communications to *Astronomische Nachrichten*, No. 3011, Prof. Pickering adds the following to his list of stars having peculiar spectra:—

Designation of star.	R.A. 1900.	Decl. 1900.	M <sup>g</sup> .	Description of spectrum.
D.M. + 54° 431	h. m.	h. m.		
	1 53.7	+54 30	9.0	III. Type. Bright hydrogen lines.
	1 53.7	+56 15	—	III. Type. " "
S.D. - 10° 513	3 30.2	- 9 53	8.0	IV. Type. " "
D.M. + 56° 686	2 33.0	+56 18	9.1	Bright lines.
D.M. + 56° 731	2 44.8	+56 31	0.5	
Cord. G.C. 22280	16 21.2	-18 14	4.6	F line bright.
S.D. - 10° 5057	19 17.7	-10 54	7.0	IV. Type.
D.M. + 36° 4028	20 17.8	+36 30	9.5	Bright lines.
Cord. G.C. 30526	22 16.6	-46 27	6.7	IV. Type.

The first and second stars on the list are in Perseus. Their spectra are similar to that of Mira Ceti. An examination of the Harvard College Observatory photographic chart plates prove that they also are variables. The fourth and fifth stars, also in Perseus, have a spectrum resembling that of the Wolf-Rayet stars in Cygnus. With respect to these it is remarked: "Probably we have here a group similar to that in Cygnus, only comprising much fainter stars, since several other objects in this region are suspected of having bright lines." The star Cordova, Gen. Cat. 22280, is  $\chi$  Ophiuchi. Its spectrum is similar to that of  $\delta$  and  $\mu$  Centauri. The spectrum of D.M. + 36° 4028 is like that of the Wolf-Rayet stars.

The hydrogen line F is bright in the spectra of Harvard Photometry 3321 ( $\nu$  Sagittarii) and 3747. In the former star the hydrogen lines are very faint, and of the same intensity as the additional dark lines. Other bright lines are also seen.

The star Cord. G.C. 15177, noted in a previous communication as having a spectrum consisting mainly of bright lines (NATURE, vol. xlii. p. 429), should be Cord. G.C. 15,220.

HARVARD COLLEGE OBSERVATORY.—A series of articles on the history of this Observatory was written last year for the

Boston *Evening Traveller* by Mr. D. W. Baker. The articles were originally addressed to the general public, and may therefore be regarded as a popular description of the work accomplished at the Harvard College Observatory during the first fifty years of its existence (1840-90). Prof. Pickering has had this material reprinted in pamphlet form. Reproductions have also been made of some of the illustrations. The large amount of important work done at this Observatory renders the pamphlet of great interest to astronomers, while the many facts brought to light for the first time give it a high value.

The results of observations made with the meridian photometer during the years 1882-88 by Prof. Pickering and Mr. Oliver Wendell, have also just been issued. The principal work done by means of this instrument is "the determination of the magnitudes of a sufficient number of stars contained in the *Durchmusterung*, and distributed with approximate uniformity, to serve for future estimates or measures of magnitude, and to enable previous estimates to be reduced to the photometric scale."

The number of stars of which observations are recorded is 20,125; so that, when the stars enumerated in vol. xxiii. of the *Annals* of this Observatory are reckoned, the total number of stars observed with the meridian photometer reaches 20,982. Measures have also been made of 166 variable stars, and of several planets and satellites. To comment upon the importance of these observations would be superfluous. The authors are to be congratulated that the comparison is completed.

#### DR. KOCH'S REMEDY FOR TUBERCULOSIS.

THE following is a translation (sent to England on Friday last through Reuter's Agency) of an article by Dr. Koch in the *Deutsche Medicinische Wochenschrift*, January 15:—

"Since the publication, two months ago, of the results of my experiments with the new remedy for tuberculosis, many physicians have received the preparation and have been enabled to make themselves acquainted with its properties through their own experiments. As far as I have been able to review the statements which have been published and the communications I have received by letter, my indications have been fully and completely confirmed. There is a general consensus of opinion that the remedy has a specific effect upon tubercular tissues, and is therefore applicable as a very delicate and sure reagent for the finding out of latent and to diagnose doubtful tubercular processes. As regards also the curative effects of the remedy, most reports agree in stating that, notwithstanding the comparatively short duration of the application of the treatment, many of the patients subjected to it have shown a more or less pronounced improvement, and it has been affirmed that in not a few cases even a cure has been established. Standing quite by itself is the assertion that the remedy may not only be dangerous in cases which have advanced too far—a fact which may at once be conceded—but also that it actually promotes the tubercular process, and is therefore injurious. During the past six weeks I myself have had the opportunity to bring together further experiences touching the curative effects and diagnostic application of the remedy in the cases of about one hundred and fifty sufferers from tuberculosis of the most varied types in the City and Moabit Hospitals; and I can only say that everything that I have latterly seen accords with my previous observations, and that there is nothing to modify in what I before reported. So long as it was only a question of proving the accuracy of my indications, there was no need for anyone to know what the remedy contains, or whence it is derived. On the contrary, the subsequent testing would necessarily be the more unbiased the less people knew of the remedy itself. But now that this confirmatory testing has been, as it appears to me, sufficiently carried out, and has proved the importance of the remedy, the next task is to extend the study of the remedy beyond the field of its heretofore application, and, if possible, to apply the principles underlying the discovery to other diseases also. This task naturally demands a full knowledge of the remedy, and I therefore consider the time to have come when the requisite indications in this direction should be made; and this is done in what follows.

"Before I go into the remedy itself, I deem it necessary, for the better understanding of its mode of operation, to state briefly the way by which I arrived at the discovery. If a healthy guinea-pig is inoculated with the pure cultivation (*Kultur*)

of the tubercle bacilli, the inoculation wound mostly closes over with sticky matter, and appears in the early days to heal. It is only after ten to fourteen days that a hard nodule presents itself, which, soon breaking, forms an ulcerating sore until the death of the animal. Quite a different condition of things occurs when a guinea-pig which is already suffering from tuberculosis is inoculated. The best adapted for this purpose are animals which have been successfully inoculated four to six weeks before. In such an animal the small inoculation assumes the same sticky covering at the beginning, but no nodule forms. On the contrary, on the following, or on the second day, the place of inoculation shows a strange change. It becomes hard, and assumes a darker colouring, which is not confined to the inoculation spot, but spreads to the neighbouring parts until it attains a diameter of 0.5 to 1 centimetre. In the course of the next few days it becomes more and more manifest that the skin thus changed is necrotic, and it finally falls off, leaving a flat ulceration, which usually heals rapidly and permanently, without any cutting into the adjacent lymphatic glands. Thus the injected tubercular bacilli have a quite different effect upon the skin of a healthy guinea-pig from that of one affected with tuberculosis. This effect is not exclusively produced with living tubercular bacilli, but is also observed with dead bacilli, the result being the same whether, as I discovered by experiments at the outset, they are killed by somewhat prolonged application of low temperatures or boiling heat, or by means of certain chemicals. This peculiar fact I followed up in all directions, and this further result was obtained—that killed pure cultivations of tubercular bacilli, after being diluted in water, might be injected in great quantities under the skin of a healthy guinea-pig without [anything] occurring beyond local suppuration. (Professor Koch here interpolates a note to the effect that such injections belong to the simplest and surest means of producing suppuration free from living bacteria.) Tuberculous guinea-pigs, on the other hand, are killed by the injection of very small quantities of such diluted cultivations; in fact, within six to forty-eight hours, according to the strength of the dose. An injection which does not suffice to produce the death of the animal may cause extended necrosis of the skin in the vicinity of the place of injection. If the dilution is still further diluted so that it is scarcely visibly clouded, the animals inoculated remain alive. There soon supervenes a noticeable improvement in their condition. If the injections are continued at intervals of one to two days, the ulcerating inoculation wound becomes smaller, and finally scars over, which otherwise is never the case. Further, the swollen lymphatic glands are reduced in size, the body becomes better nourished, and the morbid process comes to a standstill, unless it has gone too far, and the animal perishes from exhaustion.

"By this means the basis of the curative process against tuberculosis was established. Against the practical application of such dilutions of dead tubercle bacilli there presented itself the fact that the tubercle bacilli are not absorbed at the inoculation points nor do they disappear in other way, but for a long time remain unchanged and engender greater or smaller suppurative foci. Anything, therefore, that was to exercise a healing effect on the tubercular process must be a soluble substance which would be lixiviated to a certain extent by the fluids of the body floating round the tubercle bacilli, and be transferred fairly rapidly to the juices of the body, while the substance which produces suppuration apparently remains behind in the tubercular bacilli, or in any case dissolves but very slowly. The only important point, therefore, was to bring about outside the body the process which goes on inside, and, if possible, to extract from the tubercular bacilli alone the curative substance. This demanded much time and toil until I succeeded at last, with the aid of a 40 to 50 per cent. solution of glycerine, in obtaining the effective substance from the tubercular bacilli. With the fluids so obtained I made further experiments on animals, and finally on human beings. These fluids were given to other physicians in order that they might repeat the experiments. The remedy with which the new treatment against tuberculosis is practised is thus a glycerine extract from pure cultivations of the tubercle bacilli. Into the simple extracts there naturally passes from the tubercular bacilli, besides the effective substance, all the other matter soluble in 50 per cent. glycerine. Consequently there are in it a certain quantity of mineral salts, colouring substances, and other unknown extractive matter. Some of these substances can be removed from it tolerably easily. The effective substance is, namely, insoluble in absolute alcohol and can be precipitated by it, not indeed in

a pure condition, but still combined with the other extractive matter which is likewise insoluble in alcohol. The colouring matter may also be removed, so that it is possible to obtain from the extract a colourless dry substance which contains the effective principle in a much more concentrated form than the original glycerine solution.

For application in practice, however, this purification of the glycerine extract offers no advantage, because substances so eliminated are unessential for the human organism, and the process of purification would make the cost of the remedy unnecessarily high. As regards the constitution of the more effective substance, only surmises may for the present be expressed. It appears to me to be a derivative from albuminous bodies, and to have a close affinity to them. It does not belong to the group of so-called tox-albumens, because it bears high temperatures, and in the dialyser goes easily and quickly through the membrane. The proportion of the substance in the extract is to all appearance very small. I estimate it at fractions of 1 per cent. If my assumption is correct, we should therefore have to do with a matter the effect of which upon organisms attacked with tuberculosis goes far beyond what is known to us of the strongest drugs. Regarding the manner in which the specific action of the remedy on tuberculous tissue is to be represented, various hypotheses may naturally be put forward. Without wishing to affirm that my view affords the best explanation, I represent the process to myself in the following manner. The tubercle bacilli produce, when growing in living tissues, just as artificial cultivations do, certain substances which variously and notably unfavourably influence the living elements in their vicinity—namely, the cells. Among these is a substance which in a certain degree of concentration kills the living protoplasm and so alters it that it passes into the condition described by Weigert as coagulation necrosis. In the tissue which has thus become necrotic the bacilli find such unfavourable conditions of nourishment that it can grow no more and sometimes finally dies. This is how I explain the remarkable phenomenon that in organs which are newly attacked with tuberculosis, as, for instance, in the spleen and liver of a guinea-pig which is covered with gray nodules, numbers of bacilli are found, whereas they are rare or wholly absent when an enormously enlarged spleen consists almost entirely of a whitish substance in a condition of coagulation necrosis, as is often found in cases of natural death in tuberculous guinea-pigs. The single bacillus cannot, therefore, bring about necrosis at a great distance, for as soon as the necrosis has attained a certain extension the growth of the bacillus subsides, and therewith the production of the necrotizing substance. There thus occurs a kind of reciprocal compensation, which causes the vegetation of isolated bacilli to remain so extraordinarily restricted, as, for instance, in lupus, scrofulous glands, &c. In such a case the necrosis generally extends only to a part of the cells, which then, with further growth, assumes the peculiar form of the *Riesenselle*, or giant cell. Thus, in this interpretation, I follow the first explanation given by Weigert of the production of giant cells.

If now one were to increase artificially in the vicinity of the bacillus the amount of necrotizing substance in the tissue, the necrosis would spread to a greater distance, and thereby the conditions of nourishment for the bacillus would become much more unfavourable than usual. In the first place, the tissue which had become necrotic over a larger extent would decay, detach itself, and, where such were possible, carry off the enclosed bacilli and eject them outwardly; and in the second place, the bacilli would be so far disturbed in their vegetation that they would much more speedily be killed than under ordinary circumstances. It is just in the evoking of such changes that the effect of the remedy appears to me to consist. It contains a certain quantity of necrotizing substance, a corresponding large dose of which injures certain tissue elements even in a healthy person, and, perhaps, the white blood corpuscles or the cells adjacent thereto, and consequently produces fever and a quite remarkable complication of symptoms. With tuberculous patients, on the other hand, a much smaller quantity suffices to induce at certain places—namely, where the tubercle bacilli are vegetating and have already impregnated the adjacent region with the same necrotizing matter—more or less extensive necrosis of the cells, together with the phenomena in the whole organism which result from and are connected with it. In this way, for the present at least, it is possible to explain the specific influence which the remedy, in accurately defined doses, exercises

upon tuberculous tissue, and further, the possibility of increasing these doses with such remarkable rapidity, and the remedial effects which have been unquestionably produced under not too favourable circumstances.

Regarding the duration of the remedy, Prof. Koch observes in a note that, of the consumptive patients who were described by him as temporarily cured, two have been again received into the Moabit Hospital for further observation, that no bacilli have appeared in the sputum for three months past, and that the physical symptoms have also gradually but completely disappeared.

## GASEOUS ILLUMINANTS.<sup>1</sup>

### III.

IT has been proposed to carburet and enrich poor coal gas by admixture with it of an oxy-oil gas, in which crude oils are cracked at a comparatively low temperature, and are then mixed with from 12 to 24 per cent. of oxygen gas. Oil gas made at low temperature is *per se* of little use as an illuminant, as it burns with a smoky flame, and does not travel well; but, when mixed with a certain amount of oxygen, it gives a very brilliant white light and no smoke, while, as far as experiments have at present gone, its travelling powers are much improved. At first sight it seems a dangerous experiment to mix a heavy hydrocarbon gas with oxygen; but it must be remembered that, although hydrogen and carbon monoxide only need to be mixed with but half of their own volume of oxygen to produce the most explosive compound, yet as the number of carbon and hydrogen atoms in the combustible gas increases, so does the amount of oxygen needed. So that coal gas requires rather more than its own volume, and ethylene three times its volume, to yield the maximum explosive results; while these mixtures begin to be explosive when 10 per cent. of oxygen is combined with hydrogen or water gas, 30 per cent. with coal gas, and more than 50 per cent. with oil gas of the character used. It is claimed that if this gas were used as an enricher of coal gas, 5 per cent. of it would increase the luminosity of 16-candle gas by about 40 per cent. Oxygen has been obtained for some time past from the air, on a commercial scale, by the Brin process; and it is now proposed to make oxygen by a process first introduced by Tessié du Motay, which consists of passing alternate currents of steam and air over sodic manganate heated to dull redness in an iron tube. The process has never been commercially successful, for the reason that the contents of the tube fused, and, flowing over the surface of the iron, rapidly destroyed the tubes or retorts; and also, as soon as fusion took place, the mass became so dense that it had little or no action on the air passing over it; but it is now claimed that this trouble can be overcome. Cheap oxygen would be an enormous boon to the gas manager, as, by mixing 0.8 per cent. of oxygen with his coal gas before purification, he could not only utilize the method so successfully introduced by Mr. Valon at Ramsgate, but could also increase the illuminating value of his gas to a slight extent.

No ordinary gas flame is in contact with the burner from which it issues, this being due to the cooling effect of the burner; but as this only affects the bottom of the flame, with a small flame the total effect is very great; with a large flame almost *nil*. The first point, therefore, to attend to in making a good burner is that it should be made of a good non-conductor. In the next place, the flow of the gas must be regulated to the burner; as, if you have a pressure higher than that for which the burner is constructed, you at once obtain a roaring flame and a loss of illuminating power, as the too rapid rush of gas from the burner causes a mingling of gas and air, and a consequent cooling of the flame, while the form of the flame becomes distorted. The tap also which regulates the flame is better at a distance from the burner than close to it; as any constriction near the burner causes eddies in the flow of the gas, which gives an unsteady flame. These general principles govern all burners.

We will now take the ordinary forms in detail. In the flat-flame burner, given a good non-conducting material and a well-regulated gas supply, little more can be done, while burning it

<sup>1</sup> Continued from p. 260. Conclusion of the Can'tor Lectures delivered at the Society of Arts by Prof. Lewis.

in the ordinary way, to increase its luminosity; and it is the large surface of flame exposed to the cooling action of the air which causes this form of burner to give the lowest service of any per cubic foot of gas consumed. Much is done, moreover, by faulty fittings and shades, to reduce the already poor light afforded, because the light-yielding power of the flame largely depends on its having a well-rounded base and broad luminous zone; and when a globe with narrow opening is used with such a flame, as is done in ninety-nine cases out of a hundred, the up-draught drags the flame out of shape, and seriously impairs its illuminating power—a trouble which can be overcome by having a globe with an opening at the bottom not less than 4 inches in diameter, and having small shoulders fixed to the burner, which draw out the flame and protect the base from the disturbing influence of draughts.

The Argand burner differs from the flat-flame burner in that a circular flame is employed, and the air supply is regulated by a glass of cylindrical form. This kind of burner gives better service than a flat-flame, as not only can the supply of gas and air be better adjusted, but the air, being slightly warmed by the hot glass, adds to the temperature of the flame, which is also increased by radiation from the opposite side of the flame itself. The chief loss of light depends upon the fact that, being circular, the light from the inner surface has to pass through the wall of flame; and careful photometric experiments show that the solid particles present in the flame so reduce its transparency that a loss amounting to about 25 per cent. of light takes place during its transmission.

For many years no advance was made upon these forms of burner. But when, fifteen years ago, it was recognized that anything which cools the flame reduces its value, while anything which increases its temperature raises its illuminating power, a change began to steal over the forms of burner in use; and the regenerative burners, fathered by such men as Siemens, Grimsen, and Bower, commenced what was really a revolution in gas lighting, by utilizing the heat contained in the escaping products of combustion to raise the temperature of the gas and air which are to enter into combination in the flame. An enormous increase in the temperature of the solid particles of carbon in the flame is thereby obtained; and a far greater and whiter light is the result.

The only drawback to this class of burner is that it is by far the best form of gas stove as well as burner, and that the amount of heat thrown out by the radiant solid matter in the flame is, under some circumstances, an annoyance. On the other hand, we must not forget that this is the form of burner best adapted for overhead lighting, and that nearly every form of regenerative lamp can be used as a ventilating agent; and that with the withdrawal of the products of combustion from the air of the room, the great and only serious objection to gas as an illuminant disappears.

When coal gas is burnt, the hydrogen is supposed to be entirely converted into water vapour, and the carbon to finally escape into the air as carbon dioxide. If this were so, every cubic foot of gas consumed would produce approximately 0.523 cubic foot of carbon dioxide, and 1.34 cubic feet of water vapour; and the illuminating power yielded by the foot of gas will, of course, vary with the kind of burner used.

Roughly speaking, the ordinary types of burner give the following results:—

	Illuminating power in candles per c. ft. of gas consumed.	Products of combustion per candle power.	
		Carbon dioxide.	Water vapour.
		c. ft.	c. ft.
Batwing ...	2.9	0.18	0.46
Argand ...	3.3	0.16	0.40
Regenerative...	10.0	0.05	0.13

So that the regenerative forms of burner, by giving the greatest illuminating power per cubic foot of gas consumed, yield a smaller amount of vitiation to the air per candle of light emitted. An ordinary room (say, 16 feet by 12 feet by 10 feet) would not be considered properly illuminated unless the light were at least

equal to 32-candle power; and in the following table the amount of oxygen used up, and the products of combustion formed by each class of illuminant and burner, in attaining this result, are given. The number of adults who would exhale the same amount during respiration is also stated:—

Illuminants.	Quantity of materials used.	Oxygen reu.oved.	Products of combustion		Adults.
			Water vapour.	Carbon dioxide.	
	grs.	c. ft.	c. ft.	c. ft.	
Sperm candles ...	3840	19.27	13.12	13.12	21.8
Paraffin oil ...	1984	12.48	7.04	8.96	14.9
Gas (London)—	c. ft.				
Batwing ...	11.0	13.06	14.72	5.76	9.6
Argand ...	9.7	11.52	12.80	5.12	8.5
Regenerative ...	3.2	3.68	4.16	1.60	2.6

From these data it appears, according to scientific rules by which the degree of vitiation of the air in any confined space is measured by the amount of oxygen used up and carbon dioxide formed, that candles are the worst offenders against health and comfort; oil-lamps come next; and gas least. This, however, is an assumption which practical experience does not bear out. Discomfort and oppression in a room lighted by candles or oil are less felt than in one lighted by any of the older forms of gas-burner. The partial explanation of this is to be found in the fact that, when a room is illuminated with candles or oil, people are contented with a feeble and more local light than when using gas. In a room of the size described, the inmates would be more likely to use two candles placed near their books or on a table, than 32 candles scattered about the room. Moreover, the amount of water vapour given off during the combustion of the gas is greater than in the case of the other illuminants. Water vapour, having a great power of absorbing radiant heat from the burning gas, becomes heated; and, diffusing itself about the room, causes a great feeling of oppression. The air also, being highly charged with moisture, is unable to take up so rapidly the water vapour which is always evaporating from the surface of the skin, whereby the functions of the body receive a slight check, resulting in a feeling of *malaise*. Added to these, however, is a far more serious factor, which, up to the present, has been overlooked, and that is that an ordinary gas-flame in burning yields distinct quantities of carbon monoxide and acetylene, the prolonged breathing of which in the smallest traces produces headache and general physical discomfort, while their effect upon plant life is equally marked.

Ever since the structure of flame has been noted and discussed, it has been accepted as a fact beyond dispute that the outer, almost invisible, zone which is interposed between the air and the luminous zone of the flame is the area of complete combustion; and that here the unburnt remnants of the flame gases, meeting the air, freely take up oxygen, and are converted into the comparatively harmless products of combustion—carbon dioxide and water vapour—which only need partial removal by any haphazard process of ventilation to keep the air of the room fit to support animal life. I have, however, long doubted this fact; and at length, by a delicate process of analysis, have been able to confirm my suspicions. The outer zone of the luminous flame is not the zone of complete combustion. It is a zone in which luminosity is destroyed in exactly the same way that it is destroyed in the Bunsen burner—i.e. the air penetrating the flame so dilutes and cools down the outer layer of incandescent gas that it is rendered non-luminous, while some of the gas sinks below the point at which it is capable of burning, with the result that considerable quantities of the products of incomplete combustion (carbon monoxide and acetylene) escape into the air, and render it actively injurious. I have proved this by taking a small platinum pipe with a circular loop at the end, the interior of the loop being pierced with minute holes; and by making a circular flame burn within the loop, so that the non-luminous zone of the flame just touched the inside of the loop, and then by aspiration so gentle as not to distort the shape of the flame, withdrawing the gases escaping from the outer zone, and analysing these by a process which will be described elsewhere, I arrived at the following results:—

*Gases Escaping from the Outer Zone of Flame.*

	Luminous.	Bunsen.
Nitrogen ... ..	76.612	80.242
Water vapour ... ..	14.702	13.345
Carbon dioxide ... ..	2.201	4.966
Carbon monoxide ... ..	1.189	0.006
Oxygen ... ..	2.300	1.430
Marsh gas ... ..	0.072	0.003
Hydrogen ... ..	2.388	0.008
Acetylene ... ..	0.036	nil
	100.000	100.000

The gases leaving the luminous flame show that the diluting action of the nitrogen is so great that considerable quantities even of the highly-inflammable and rapidly-burning hydrogen escape combustion, while the products of incomplete combustion are present in sufficient quantity to perfectly account for the deleterious effects of gas-burners in ill-ventilated rooms. The analyses also bring out very clearly the fact that, although the dilution of coal gas by air in atmospheric burners is sufficient to prevent the decomposition of the heavy hydrocarbons, with liberation of carbon, and so destroy luminosity, yet the presence of the extra supply of oxygen does make the combustion far more perfect, so that the products of incomplete combustion are hardly to be found in the escaping gases.

The feeling has gradually been gaining ground in the public mind that, when atmospheric burners and other devices for consuming coal gas are employed for heating purposes, certain deleterious products of incomplete combustion find their way into the air; and that this does take place to a considerable extent is shown by the facts brought forward in a paper read by Mr. W. Thomson at the last meeting of the British Association, at Leeds. Mr. Thomson attempted to separate and determine the quantity of carbon monoxide and hydrocarbons found in the flue gases from various forms of gas stoves and burners; but, like every other observer who has tried to solve this most difficult problem, he found it so beset with difficulties that he had to abandon it, and contented himself with determining the total quantities of carbon and hydrogen escaping in an unburnt condition. His experiments proved that the combustion of gas in stoves for heating purposes is much more incomplete than one had been in the habit of supposing; but they did not show whether the incompletely burnt matter consisted of such deleterious products as carbon monoxide and acetylene, or comparatively harmless gases such as marsh gas and hydrogen.

If a cold substance—metallic or non-metallic—be placed in a flame, whether it be luminous or non-luminous, it will be observed that there is a clear space, in which no combustion is taking place, formed round the cool surface, and that, as the body is heated, this space becomes gradually less, until, when the substance is at the same temperature as the flame itself, there is contact between the two. Moreover, when a luminous flame is employed in this experiment, the space still exists between the cool body and the flame; but it will also be noticed that the luminosity is decreased over a still larger area, though the flame exists. This means that, in immediate contact with the cool body, the temperature is so reduced that a flame cannot exist, and so is extinguished over a small area; while over a still larger space the temperature is so reduced that it is not hot enough to bring about decomposition of the heavy hydrocarbons, with liberation of carbon, to the same extent as in hotter portions of the flame.

Now, inasmuch as, when water is heated or boiled in an open vessel, the temperature cannot rise above 100° C., and as the temperature of an ordinary flame is more than 1000° C., it is evident that the burning gas can never be in contact with the bottom of the vessel; or, in other words, the gas is put out before combustion is completed, and the unburnt gas and products of incomplete combustion find their way into the air, and render it perfectly unfit for respiration. The portion of the flame which is supposed to be the hottest is about half an inch above the tip of the inner zone of the flame. It is at this point that most vessels containing water to be heated are made to impinge on the flame; and it is this portion of the flame also that is utilized for raising various solids to a temperature at which they will radiate heat in most forms of gas-stove.

I have determined the composition of the products of combustion and the unburnt gases escaping when a vessel containing

water at the ordinary temperature is heated up to boiling-point by a gas-flame; the vessel being placed, in the first case, half an inch above the inner cone of the flame, and in the second at the extreme outer tip of the flame. The results are given in the following table:—

*Gases Escaping during Checked Combustion.*

	Bunsen flame.		Luminous flame.	
	Inner.	Outer.	Inner.	Outer.
Nitrogen ... ..	75.75	79.17	77.52	69.41
Water vapour ... ..	13.47	14.29	11.80	19.24
Carbon dioxide ... ..	2.99	5.13	4.93	2.38
Carbon monoxide ... ..	3.69	nil	2.45	2.58
Marsh gas ... ..	0.51	0.31	0.95	0.39
Acetylene ... ..	0.04	nil	0.27	nil
Hydrogen ... ..	3.55	0.47	2.08	nil
	100.00	100.00	100.00	100.00

These figures are of the greatest interest, as they show conclusively that the extreme tip of the Bunsen flame is the only portion which can be used for heating a solid substance without liberating deleterious gases. This corroborates the previous experiment on the gases in the outer zone of a flame, which showed that the outer zone of the Bunsen flame is the only place where complete combustion is approached. Moreover, this work sets at rest a question which has been over and over again under discussion, and that is, whether it is better to use a luminous or a non-luminous flame for heating purposes. Using a luminous flame, it is impossible to prevent a deposit of carbon, which is kept by the flame at a red heat on its outer surface; and the carbon dioxide formed by the complete combustion of the carbon already burnt up in the flame is by this reduced back to carbon monoxide. So that, even in the extreme tip of a luminous flame, it is impossible to heat a cool body without giving rise to carbon monoxide, although, acetylene being absent, gas-stoves in which small flat-flame burners are used have not that subtle and penetrating odour which marks the ordinary atmospheric burner stove with the combustion checked just at the right spot for the formation of the greatest volume of noxious products. It is the contact of the body to be heated with the flame before combustion is complete that gives rise to the great mischief. Any cooling of the flame extinguishes a portion of it; and the gases present in it at the moment of extinction creep along the cooled surface, and escape combustion.

In utilizing a flame for heating purposes, combustion must be completed before any attempt is made to use the heat; in other words, the products of combustion and not the flame must be used for this purpose.

I think I have said enough to show that no geyser or gas-stove should be used without ample and thorough means of ventilation, being provided; and no trace of the products of combustion should be allowed to escape into the air. Until this is done, the use of improper forms of stoves will continue to inflict serious injury on the health of the people using them; and this will gradually result in the abandonment of gas as a fuel, instead of, as should be the case, its coming into general use.

Let us now consider for a moment what is likely to be the future of gas during the next half-century. The labour troubles, bad as they are and have been, will not cease for many a weary year. The victim of imperfect education—more dangerous than none at all, as, while destroying natural instinct, it leaves nothing in its place—will still listen to, and be led by the baneful influence of irresponsible demagogues, who care nothing so long as they can read their own inflammatory utterances in the local press, and gain a temporary notoriety at the expense of the poor fools whose cause they profess to serve. The natural outcome of this will be that every possible labour-saving contrivance will be pressed into the gas manager's service, and that, although coal (of a poorer class than that now used) will still be employed as the source of gas, the present retort-setting will quickly give way to the inclined retorts on the Coze principle; while, instead of the present wasteful method of quenching the red-hot coke, it will, as far as it can be used, be shot direct into the generator of the water gas plant, and the water gas, carburetted with the benzene hydrocarbons derived from the smoke of the

blast-furnaces and coke-ovens, or from the creosote oil of the tar-distiller, by the process foreshadowed in the concluding sentences of the preceding lecture, will then be mixed with the gas from the retorts, and will supply a far higher illuminant than we at present possess. In parts of the United Kingdom, such as South Wales, where gas coal is dear and anthracite and bastard coals are cheap, water gas, highly carburetted, will entirely supplant coal gas, with a saving of 50 per cent. on the prices now existing in these districts.

While these changes have been going on, and improved methods of manufacture have been tending to the cheapening of gas, it will have been steadily growing in public favour as a fuel; and if, in years to come, the generation of electricity should have been so cheapened as to allow the electric light to successfully compete with gas as an illuminant, the gas-works will still be found as busy as of yore, and the holder of gas shares as contented as he is to-day; for, with the desire for a purer atmosphere and white mist instead of yellow fog, gas will have largely supplanted coal as a fuel, and gas-stoves, properly ventilated and free from the reproaches I have hurled at them to-night, will burn a gas far higher in its heating power than that we now use, far better as regards its capacity for bearing illuminating hydrocarbons, and entirely free from poisonous constituents. As soon as the demand for it arises, hydrogen gas can be made as cheaply as water gas itself; and when the time is ripe for a fuel gas for use in the house, it is hydrogen and not water gas that will form its basis. With carburetted water gas and 20 per cent. of carbon monoxide, we shall still be below the limit of danger; but a pure water gas, with more than 40 per cent. of the same insidious element of danger, will never be tolerated in our households. Already a patent has been taken by Messrs. Crookes and Ricarde-Seaver for purifying water gas from carbon monoxide, and converting it mainly into hydrogen by passing it at a high temperature through a mixture of lime and soda lime—a process which is chemically perfect, as the most expensive portion of the material used could be recovered.

From the earliest days of gas making the manufacture of hydrogen by the passage of steam over red-hot iron has been over and over again mooted and attempted on a large scale; but several factors have combined to render it futile. In the first place, for every 478·5 cubic feet of hydrogen made under perfect theoretical conditions never likely to be obtained in practice, 56 pounds of iron were converted into the magnetic oxide; and as there was no ready sale for this article, this alone would prevent its being used as a cheap source of hydrogen. The next point was that, when steam was passed over the red-hot iron, the temperature was so rapidly lowered that the generation of gas could only go on for a very short period. Finally, the swelling of the mass in the retort, and the fusion of some of the magnetic oxide into the side, renders the removal of the spent material almost an impossibility. These difficulties can, however, be overcome. Take a fire-clay retort 6 feet long, and 1 foot in diameter, and cap it with a casting bearing two outlet tubes closed by screw-valves, while a similar tube leads from the bottom of the retort. Enclose this retort, set on end, by a furnace chamber of iron, lined with fire-brick, leaving a space of 2 feet 6 inches round the retort; and connect the top of the furnace chamber with one opening at the top of the upright retort, while an air-blast is led into the bottom of the furnace chamber below rocking fire-bars, which start at the bottom of the retort, and slope upwards to leave room for ash-holes closed by gas-tight covers. The retort is filled with iron or steel borings—alone if pure hydrogen is required, or cast into balls with pitch if a little carbon monoxide is not a drawback, as in foundry work. The furnace chamber is filled with coke, fed in through man-holes or hoppers in the top, and the fuel being ignited, the blast is turned on, and the mixture of nitrogen and carbon monoxide formed passes over the iron, heating it to a red heat, while the incandescent coke in contact with the retort does the same thing. When the fuel and retort full of iron are at a cherry-red heat, the air-blast is cut off, and the pipe connecting the furnace and retort, together with the pipe in connection with the bottom of the retort, is closed. Steam, superheated by passing through a pipe led round the retort or interior wall of the furnace, is injected at the bottom of the red-hot mass of iron, which decomposes it, forming magnetic oxide of iron and hydrogen, which escapes by the second tube at the top of the retort, and is led away—to a carburetted chamber if required for illumination, or else direct to the gas-holder

if wanted as a fuel: the mass of incandescent fuel in the furnace chamber surrounding the retort keeping up the temperature of the retort and iron sufficiently long to enable the decomposition to be completed. The hydrogen and steam valves are now closed, and the air-blast turned on; and the hot carbon monoxide, passing over the hot magnetic oxide, quickly reduces it down again to metallic iron, which, being in a spongy condition, acts more freely on the steam during later makes than it did at first, and, being infusible at the temperature employed, may be used for a practically unlimited period. What more simple method than this could be desired? Here we have the formation of the most valuable of all fuel gases at the cost of the coke and steam used—a gas also which has double the carrying power for hydrocarbon vapours possessed by coal gas, while its combustion gives rise to nothing but water vapour.

### UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Candidates for the newly founded Clerk-Maxwell Scholarship in Experimental Physics are requested to send their names to Prof. Thomson, 6 Scroope Terrace, Cambridge, before February 21. Each candidate is requested to forward a statement of the original work which, in accordance with the conditions of the tenure of the Scholarship, he would undertake if elected.

The University Lecturer in Geography (J. Y. Buchanan, F.R.S.) announces a course of lectures in Physical Geography and Climatology, to be given on Mondays and Wednesdays, at 10 a.m., beginning January 26.

The degree of M.A. *honoris causa* is to be conferred on James Alfred Ewing, F.R.S., Professor of Mechanism and Applied Mechanics, who gave his inaugural lecture on Tuesday, January 20. His subject was "The University Training of Engineers."

On Monday, January 26, the following communications will be made to the Philosophical Society:—Prof. J. J. Thomson, on the electric discharge through rarefied gases without electrodes; Mr. J. Larmor, St. John's College, on diffraction at caustic surfaces.

### SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for December 1890 contains an account, by H. J. Cox, of a waterspout which occurred at Newhaven, Connecticut, on October 19 last, between two thunderstorms about five miles apart. A funnel-shaped cloud rapidly descended, while the water below it rose upward, first about 3 feet, and, when the spout was complete, above 30 feet. The spout was about 300 feet high, and 25 feet in diameter. It moved about two miles in ten minutes, and when it met the thunderstorm it moved back in the opposite direction about a mile.—A summary of Dr. Hann's paper on temperature in anticyclones and cyclones, the subject of which has already been noticed in NATURE.—Observations and studies on Mount Washington, by Prof. Hazen, to determine, by means of the sling hygrometer, the temperature and humidity at each mile by walking down the mountain and up again. The results of sixteen journeys show that in the cases with partly dry air the decrease of temperature with elevation did not differ widely from the theoretical value, but with moist air the theoretical difference per 100 feet was much less than the observed difference.—Cyclones and tornadoes in North America, by J. Brucker. The object of the paper is to show that tornadoes or local air-whirls are analogous to water-whirls, and the subject is illustrated by diagrams.—The cooling of dry and moist air by expansion, by Prof. Marvin. The author refutes Prof. Hazen's objections to the principle that moist or saturated air is warmed by the latent heat set free from that portion of the vapour that is condensed by expansion. Prof. Marvin states, *inter alia*, that Prof. Hazen's calculations are not made by the proper thermodynamic equations, and are incorrect. Prof. Hazen, on the other hand, offers a prize of 100 dollars for the proof of the proposition, that Espy's experiments, when properly interpreted, prove his theory.

# SOCIETIES AND ACADEMIES. LONDON.

**Royal Society, December 18, 1890.**—"On Certain Conditions that Modify the Virulence of the Bacillus of Tubercle." By Arthur Ransome, M.D., F.R.S.

In order to test the influence of light, air, and dry soils upon the virulence of the bacillus of tubercle, the following series of experiments were devised.

It was decided to expose tuberculous sputum—

(a) In a locality (Bowdon) where the soil was dry and sandy (about 100 feet in thickness), and where very few cases of phthisis were known to have originated. It was to be placed in full daylight or sunlight, and exposed to abundant streams of fresh country air.

(b) A portion of the same sputum would be exposed under similar conditions, in the same place, with the exception that it would be put into a darkened chamber.

(c) A third portion would be taken to a small four-roomed tenement in Manchester, on a clay soil, without cellarage, and badly ventilated, but it would be placed on the window-ledge, with as much light as could there be obtained.

(d) A portion would be placed in the same cottage, but in a dark corner of a sleeping-room in which it was known that three deaths from phthisis had occurred within the space of six or seven years.

(e) Finally, a portion would be exposed to used air coming from a ward in a Consumption Hospital in Bowdon, in darkness.

Two collections of sputum were obtained—

(a) From a woman dying of phthisis, collected on April 25. This specimen contained comparatively few bacilli.

(b) Also from a woman in an advanced stage of phthisis. This sputum contained abundance of bacilli.

These collections of sputum were divided into portions, and placed in watch-glasses marked A.1, A.2, A.3, B.1, . . . B.10. Some of these watch-glasses were exposed without further arrangement, but others, where there might be a possibility of infection, were inclosed in cages, so arranged that air could reach them through a thin layer of cotton-wool.

These watch-glasses were then exposed for five weeks under the conditions already noted, commencing on April 29, 1890, with the exception of B.9 and 10, which were started on May 2. Most of the specimens were withdrawn on June 3; but one, B.10, was divided on May 12, and a portion—B.10.(b)—was introduced into a glass bulb and exposed for several minutes each day to a current of ozonized oxygen.

All the specimens were then inclosed in a box, and forwarded to the Pathological Laboratory, Owens College, where Dr. Dreschfeld, the Professor of Pathology, had kindly undertaken to carry out the necessary inoculations. The animals used were rabbits, kept under favourable hygienic conditions. The dried sputum was mixed with sterilized water, to form a pasty mass, and this was inserted into the subcutaneous tissue of the back. All the instruments used were made thoroughly aseptic.

None of the four specimens of sputum exposed to fresh air and light on a dry soil conveyed the disease, but one of the three portions exposed under similar conditions in darkness produced tubercle.

Of the two exposed in the cottage in Ancoats, in the light, one produced tubercle; and of the two specimens exposed in the same place, in comparative darkness, one caused tubercle, the other did not.

Lastly, the specimen placed in the ventilating shaft from a ward in the Consumption Hospital, Bowdon, on a dry soil, conveyed the disease; and the portion removed from it after ten days, and exposed to the action of ozonized oxygen, did not produce tubercle.

These experiments are too few in number to justify the statement of positive conclusions, but, so far as they extend, they go to prove that fresh air and light and a dry sandy soil have a distinct influence in arresting the virulence of the tubercle bacillus; that darkness somewhat interferes with this disinfectant action; but that the mere exposure to light in otherwise bad sanitary conditions does not destroy the virus. There are some indications that the cotton-wool envelope interferes with the operation of the external conditions, whether for good or evil.

January 8.—"On the Minute Structure of Striped Muscle, with Special Reference to a New Method of Investigation by means of 'Impressions' stamped in Collodion." By John

Berry Hayercraft, M.D., D.Sc., F.R.S.E. Communicated by Dr. Klein, F.R.S. (From the Physiological Laboratory, University of Edinburgh.)

The author has held since 1880 that the cross striping seen on examining a muscular fibre by the aid of a microscope is due to the fact that the fibrils of which the muscle is composed are varicose in form, presenting alternating swellings and contractions. The striping, according to him, is the optical effect of their form, and not of their internal structure as is almost universally believed. Recently he has discovered very convincing proof of the truth of his opinions. It occurred to him to endeavour to "stamp" some soft material with muscular tissue, and to examine the "impression" or "intaglio" under the microscope: if this intaglio showed the cross striping, it of course would follow that this could be accounted for by the form of the muscle used as the "stamp." After experimenting for some months, he at last succeeded in his purpose, having found a suitable medium in a moist film of collodion. The properties of this film he found were very remarkable, for with it it is possible to take impressions of details too small to be recognized by any but the higher powers of the microscope. Such a film, pressed for a second or so against the back of the hand and then withdrawn, not only shows impressions of the tiny hairs covering the hand, but when examined under the microscope the minutest details of the imbricated scales of which they are composed come out far more clearly than when the somewhat opaque hair is itself examined. When the film is gently pressed upon some fresh or preserved muscle, the intaglio shows in every detail the striping so characteristic of the muscle, and not only so, but every change in the striping which is known to occur when the muscle contracts can be stamped as well. The intaglio in fact gives the details of the striping in whatever state of contraction or relaxation the fibre, used as a stamp, may happen to be, and it follows of course that these changes in the striping are due to changes in the form of the fibrils. In this case the most current views of contraction have to be discarded, for these explain contraction as being due to osmotic reactions between the substances which were supposed to constitute the cross stripes (these are generally held to mark the position of alternating bands of semi-fluid and solid substances). The author advances a new hypothesis relating to the stripes, which may be described as follows:—As a matter of fact, we find that, in a study of comparative histology, cross striping is found where rapidity of contraction is required; in other words, the fibrils of an unstriped fibre lose their cylindrical character, and become segmented up into tiny particles, each little particle shortening and thickening during contraction, and causing recurrent bulgings which produce the stripes. The reason of this segmentation may not unnaturally be ascribed to the fact that the smaller a contracting particle is the sooner it will reach its maximum of shortening, just as, in the case of the gross muscles, the hare can nearly keep pace with the horse, because its leaps, although shorter, are much quicker. While offering the above explanations, the author does not consider we are yet in a position to explain the phenomenon of contraction itself; and concludes by saying that, if ever we are in a position to express muscular contraction in terms of the inorganic world, it will result from a study of the lower and simpler types of contractile tissue, rather than from the highly evolved tissue of striped muscle.

"On the Reflection and Refraction of Light at the Surface of a Magnetized Medium." By A. B. Basset, M.A., F.R.S.

The object of the present paper is to endeavour to ascertain how far the electromagnetic theory of light, as at present developed, is capable of giving a theoretical explanation of Dr. Kerr's experiments (*Phil. Mag.*, May 1877, and March 1878) on the effect of magnetism on light.

In these experiments, polarized light was reflected from the polished surface of soft iron, and it was found that, when the reflector was magnetized, the reflected light exhibited certain peculiarities, which disappeared when the magnetizing current was off. It was also found that the effects of magnetization were, in most cases, reversed when the direction of the magnetizing current was reversed; that is to say, if the intensity of the reflected light was strengthened by a right-handed current, it was weakened by a left-handed one.

Since a metallic reflector was employed, the results were complicated by the influence of metallic reflection, and it therefore seems hopeless to attempt to give a complete theoretical explanation of these experiments until a satisfactory electromagnetic

theory of metallic reflection has been discovered; and this, I believe, has not yet been done.

There are, however, several non-metallic substances (such as strong solutions of certain chemical compounds of iron) which are capable, when magnetized, of producing an effect upon light; and the theoretical explanation of the magnetic action of such substances upon light is accordingly free from the difficulties surrounding metallic reflection. I have accordingly, in the present paper, attempted to develop a theory which is applicable to such media.

The theory, which is due to Prof. Rowland, is founded upon the following considerations:—

It was proved by Hall (*ibid.*, March 1880) that, when a current passes through a conductor which is placed in a strong magnetic field, an electromotive force is produced, whose intensity is proportional to the product of the current and the magnetic force, and whose direction is at right angles to the plane containing the current and the magnetic force. Prof. Rowland (*ibid.*, April 1881) has assumed that this result holds good in a dielectric which is under the action of a strong magnetic force; accordingly, the general equations of electromotive force become

$$P_i = -\frac{dF}{dt} - C(\gamma \dot{g} - \beta \dot{h}) - \frac{d\psi}{dx} \quad (1)$$

where  $\alpha$ ,  $\beta$ ,  $\gamma$  are the components of the external magnetic force, and  $C$  is a constant which depends upon the physical constitution of the medium.

Writing  $\mathcal{F}_1 = C\alpha$ , &c., it follows that, if the medium is isotropic, the equations of electric displacement are of the form

$$\frac{d^2 f}{dt^2} = \frac{1}{\mu K} \nabla^2 f + \frac{1}{4\pi\mu} \left( \mathcal{F}_1 \frac{d}{dx} + \mathcal{F}_2 \frac{d}{dy} + \mathcal{F}_3 \frac{d}{dz} \right) \left( \frac{dg}{dz} - \frac{dh}{dy} \right) \quad (2)$$

The results of the paper agree with Dr. Kerr's experiments in the following particulars:—

- (i.) The reflected light is elliptically polarized.
- (ii.) When the magnetization is parallel to the reflecting surface, no effect is produced when the incidence is normal, or when the plane of incidence is perpendicular to the direction of magnetization.
- (iii.) When the plane of incidence is parallel to the direction of magnetization, and the light is polarized in the plane of incidence, the magnetic term increases from grazing incidence to a maximum value, and then decreases to normal incidence.

The principal point of disagreement is, that in all cases the intensity of the reflected light is unchanged when the direction of the magnetizing current is reversed.

I do not think that the results of the theory can be considered altogether unsatisfactory, since they certainly explain some of Dr. Kerr's experimental results; and I am disposed to think that the disagreement is due to the disturbing influence of metallic reflection. At the same time, the question is one which can only be decided by experiment, and it is therefore most desirable that experiments on magnetized solutions should be made.

#### EDINBURGH.

Royal Society, January 5.—Prof. Chrystal, Vice-President, in the chair.—After the reading of some obituary notices, Prof. Tait communicated a paper on the soaring of birds, being a continuation of a letter from the late Mr. W. Froude to Sir W. Thomson. In the previous part of this letter, Mr. Froude had expressed the view that, when a bird soars or skims without moving its wings, an effective upward current of air must exist, of which the bird takes advantage. In one case, in which a bird seemed to soar in a glassy calm, he found that it was really soaring in the upward currents in the front of an advancing sea-breeze. He explained the skimming of albatrosses along the surface of the sea in a practical calm as due to the upward displacement of the air which necessarily occurs in the front of an advancing ocean-swell. In the continuation of the letter, now communicated, he adduces observational evidence that the birds actually do skim over this portion of the wave, and that they commence to flap whenever they pass away from it, or when the wave passes underneath them and leaves them behind. In the front of a wave, 500 feet in length and 10 feet high, advancing with a speed of 50 feet per second, the maximum speed of upward speed of the air is about 3 feet per second. In the present portion of his letter, Mr. Froude also dealt with the soaring of birds in a gale. He believed this to be due to the

same cause as that which is effective in the carrying up of drops of spray to heights of 40 or 50 feet, so thickly as to resemble a dense shower of rain. Vortices are produced in the air over the surface, and the ascending currents in these vortices move more quickly than the descending currents move. Of course, the ascending portion has proportionately less cross-area; but, on the other hand, the resistance is proportional to the square of the speed, so that the upward momentum which is communicated to a drop of water while crossing the ascending portion is greater than the downward momentum which is communicated to it while crossing the descending part. Mr. Froude believed that this fact would explain the soaring of birds in a gale. Sir W. Thomson, however, thinks that this cause, though sufficient probably to account for the raising of the water-drops, will only produce effects of the second order in the suspension of birds. He believes that Lord Rayleigh's explanation—which does not seem to have occurred to Froude—that the bird takes advantage of the greater speed of the wind at higher levels, and its less speed at lower levels, is the true one.—Prof. Tait read a note on impact, in continuation of previous notes on the same subject. He shows that solid bodies may be divided into two large classes according to the effect of impact upon them. In one of these classes the time of impact remains constant, whatever be the distortion, up to a certain limit. When this limit is exceeded, the time of impact becomes shorter as the distortion is increased. This means that Hooke's law is obeyed up to the given limit, beyond which the force of restitution increases at a greater rate than does the distortion. In the other class of substances the time of impact first increases, then remains constant, and finally diminishes, as the distortion is continuously increased. Therefore, in the first stages, the force of restitution does not increase so rapidly as the distortion increases. Cork is a typical example of the latter class; vulcanized india-rubber of the former.

January 9.—A special meeting was held, Prof. Chrystal, Vice-President, in the chair.—Dr. John Murray read a paper on the form, structure, and distribution of manganese nodules in the deep sea. He exhibited a number of specimens of the nodules. Fragments of pumice-stone, which have become water-logged and have sunk to the bottom, frequently form the nuclei. In other cases the nuclei are pieces of rock, sharks' teeth, ear-bones of whales, &c. Dr. Murray believes that the manganese is deposited from solution by way of the carbonates. While nodules are of comparatively rare occurrence in the shore deposits—blue muds—where organic life is greatest, they are found in great abundance in deep waters, where life is at a minimum.—Mr. Robert Irvine and Dr. John Gibson read a paper on the occurrence of manganese deposits in marine muds. The authors have found by experiment that manganous sulphide is dissolved and decomposed by sea-water which contains carbonic acid in solution.—Mr. J. Y. Buchanan read a paper on the composition of oceanic and littoral manganese nodules. His paper contained an analysis of nodules from the North Pacific, from the ocean south of Australia, and from the deep part of Loch Fyne. The localities, and attending circumstances, were fully described, as also were the physical characteristics of the different types of nodules. The principal object of the analysis was to determine the state of oxidation of the manganese. It was found that, in the oceanic nodules, the formula of the oxide varied from  $MnO_{1.045}$  to  $MnO_{1.979}$ , so that it consisted of almost pure  $MnO_2$ . A slight difference was found in the oxidation of the outside shell from that of the kernel, the outside portions having the formula  $MnO_{1.053}$ , while the formula of the inner portions was  $MnO_{1.974}$ . The formula of the oxide in the Loch Fyne nodules varied from  $MnO_{1.324}$  to  $MnO_{1.922}$ , so that these nodules approximated in composition to the sesquioxide,  $Mn_2O_3$ . The kernels were much richer in oxygen than were the exterior portions, the formula of one being  $MnO_{1.73}$ . A number of determinations were made with regard to the moisture, the loss on ignition, and the density of the nodules in the moist, the dry, and the ignited states, from which the apparent density of the volatile products was calculated.—Mr. Buchanan also laid on the table a number of analytical results regarding the composition of some deep-sea deposits from the Mediterranean.—Messrs. Robert Irvine and W. S. Anderson communicated a paper on the action of metallic salts on carbonate of lime, specimens being exhibited.—The reading of these papers was followed by a short discussion on the bearing of some of the above results on the conclusions arrived at in Mr. Buchanan's paper (read on December 1) regard-

ing the part played by sulphides in the formation of the ochreous deposits of the ocean. Mr. Irvine and Dr. Gibson hold that the results which they have obtained show that the manganese could never have been found in the circumstances described in Mr. Buchanan's paper. Mr. Buchanan recognized the importance of the observation, but he suggested that, although very alterable in sea-water, as it is also in fresh water, the  $MnS$  might be formed locally; and he also stated that, in his own previous paper, a transient existence alone was claimed for it. The results do not affect his views as to the formation of the ferric hydrates and of red and blue clays. Mr. Buchanan held that we are still in the dark regarding the formation of nodules.

## PARIS.

**Academy of Sciences, January 12.**—M. Duchartre in the chair.—On the hypothesis of the spheroidal shape of the earth, and on the formation of its crust, by M. H. Faye. The most recent and precise geodetic measures are brought forward to confirm Laplace's opinion that the earth is an ellipsoid of revolution. Against the objection that all the measures have been made relative to continental surfaces, and most of them in the northern hemisphere, it is urged that contemporaneous measures with the pendulum give values from which the same conclusion must be drawn; and that these have been executed in both hemispheres and on both land and water surfaces. Geological considerations are also adduced in favour of this view.—Note on fly-wheels, by M. Léauté. The dimensions and weights of fly-wheels suitable for electric lighting machinery are discussed.—On a claim of priority in favour of M. Chancourtois relative to the numerical relations between the atomic weights of elements, by MM. Lecoq de Boisbaudran and A. de Lapparent. The authors bring forward a paper presented at the Academy in 1862, and having the title "Vis tellurique; classement naturel des corps simples ou radicaux obtenu au moyen d'un système de classification hélicoïdal et numérique," as evidence of M. Chancourtois's discovery of the periodic law.—On the oscillations of a system submitted to periodic disturbances, by M. E. Vicaire.—Remarks on the theorem of the continuity of the gaseous and liquid states, by M. E. Mathias. The object of this note is the verification by experimental results, of Van der Waal's law expressing the relation between the volume, the pressure, and the absolute temperature of a fluid.—Practical solution of the problem of the emergent liquid column of a thermometer by the employment of a correcting stem, by M. C. E. Guillaume. The scale of an ordinary mercurial thermometer is only true on the supposition that the instrument is exposed at least up to the top of the liquid column, to the temperature which it is desired to measure. In order to obtain the necessary correction practically, M. Guillaume has used the stem of a thermometer having mercury in it, and graduated in the ordinary manner. Let a thermometer and a "correcting stem" be placed side by side in a bath, and have the same amount of mercury above the liquid. The thermometer will indicate approximately the temperature of the bath, and the correction will be given by the difference of the thermometer reading and the reading of the "correcting stem" expressed in terms of the former.—Variations of conductivity of insulating substances, by M. E. Branly. It is shown that many dielectrics and metallic powders increase in conductivity when subjected to the action of electric discharges.—Physical properties and molecular constitution of simple metallic bodies, by M. P. Jacobin. The following are among the conclusions arrived at: (1) for the diamagnetic metals the conductivity is sensibly proportional to the sixth power of the number of molecules; (2) for magnetic metals the conductivity is nearly inversely proportional to the sixth power of the distance between the molecules. Similarly, all the physical properties of metals of the same group are stated to depend exclusively on their molecular distance.—On the intensity of telephonic effects, by M. E. Mercadier. The conditions to be fulfilled in order to obtain the maximum effect in a telephone, are: (1) the movements of the lines of force of the field should be facilitated; (2) the greatest possible number of the bobbin wires should cut the lines of force perpendicular to their direction; (3) the thickness of the diaphragm should be diminished until it is just sufficient to absorb the greatest number of lines of force in its neighbourhood; (4) the relation between the volume of the diaphragm induced to the total volume should be as large as possible.—An apparatus of luminous projection, applicable to chemical balances, for obtaining rapid weighings, by M. A. Collot fils.—On some derivatives from phenol and naphthol, by M. J. Minquin.—On the production of higher

alcohols during alcoholic fermentation, by M. L. Lindet.—New method for the detection of olive oil and linseed oil, also applicable to butters and margarines, by M. Raoul Brullé.—Note on poisoning by mussels, by M. S. Jourdain.—Contributions to the physiology of the root, by M. Pierre Lesage.—Influence of light on the production of the prickles of plants, by M. A. Lothelier.—On the diamondiferous sands collected by M. Charles Rabot in Lapland, by M. Ch. Vélain.

## AMSTERDAM.

**Royal Academy of Sciences, December 27, 1890.**—Prof. van de Sande Bakhuyzen in the chair.—M. Beyerinck spoke of the life-history of a pigment bacterium. This organism (*Bacillus cyano-fuscus*, n.s.) is the cause of a much feared, local colouring process in Dutch cheese, called "blue illness"; and of "black glue," a calamity observed in a factory of animal bone gelatine. The natural habitat is ditch water and ground water. *Bacillus cyano-fuscus* is a *Pepton-bacterium*, i.e. it can be fed with albuminous matter alone. Thence, a solution of  $\frac{1}{2}$  per cent. pepton in common water is sufficient nutriment; gelatine or glue, egg albumen, fibrine, and caseine, are also, each alone, sufficient, but they are peptonized, before absorption, by the secretion of a powerful enzyme. This pigment is twofold: (1) deep blue spherites; (2) a dark brown diffusible colouring matter. Thereby a pepton solution becomes fully black. Coming from the wild state, the vegetation power is very active, but, by the culture at the optimum-temperature of  $15^{\circ} C.$  to  $20^{\circ} C.$ , this power weakens. In a first state of deterioration the weakened form cannot be cultivated on solid matter, such as pure gelatine, whereas it will grow still in liquid food with all its ordinary characters. In a further state the weakening process is characterized as well by the loss of the power just mentioned, as by that of the pigment production. A last step leaves the organism almost fully incapable of growth and reproduction. A long exposure of weakened cultures, in excellent but diluted food ( $\frac{1}{4}$  per cent. pepton sicum in common water), to temperatures between  $2^{\circ}$  and  $5^{\circ} C.$ , tends to restore the vegetative activity. These observations relate also to many other bacteria, and they are, no doubt, of the same order as the alterations in the virulence of contagious matter, caused by the influence of temperature.

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